Midyear Report

L AND GAS
URNAL

FRANKS RIG "DOING A DANDY JOB DRILLING with VERY LOW Moving and Rig Up Cost"

Here's the record of Franks Model 137 TD Telescoper unit, shown above, from March 9 to May 12, 1951, as reported by Davis and Davidson:

	Total Time*	Drilled	Coring and Completion Time Included	Moving to Location Cost
Job No. 1	15 days	3,181 ft.	68 hours	$531.00†
Job No. 2	10 days	3,171 ft.	51 hours	210.11
Job No. 3	10 days	3,176 ft.	52 hours	214.42
Job No. 4	15 days	3,618 ft.	152 hours	212.36
Job No. 5	15 days	5,010 ft.	16 hours	897.82‡
	65 days	18,156 ft.	339 hours	$2065.71

*Includes Rigging, Coring, Completion and Moving.

†76-mile move.

‡88-mile move including river crossing, permits, etc.

FRANKS MFG. CORP
WELL SERVICING AND DRILLING UNITS
TULSA, OKLAHOMA

FRANKS MFG. CORP
Tulsa, Okla.
Box 3218

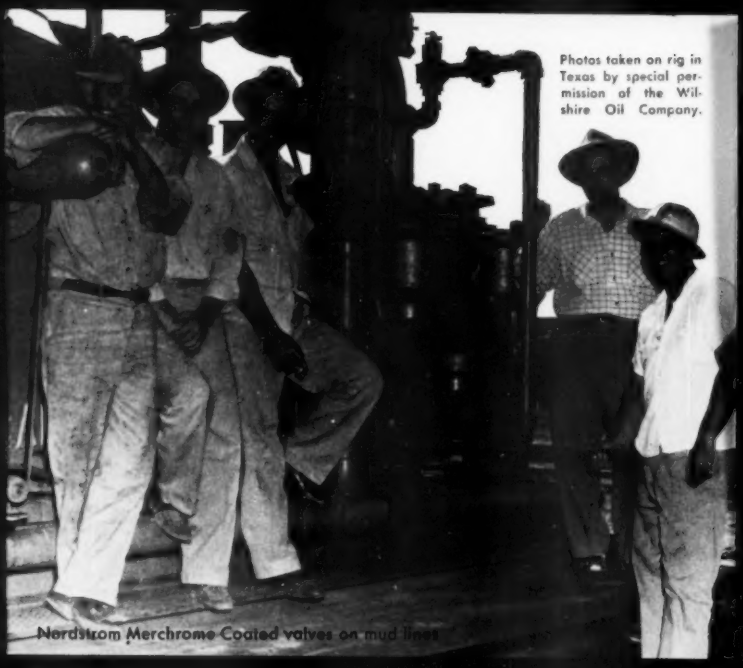
ON THE SPOT FIELD SERVICE

Although Franks units are noted for their long, maintenance-free operation, to assure users of the utmost value and least possible down time, Franks maintains "On the Spot" service centers at Odessa, Kilgore, Houston, Alice, Great Bend, Mt. Vernon,* Casper, Compton, Seminole and Tulsa. Each is complete with stocks of parts, factory trained personnel, shop facilities and 24-hour service. Investigate before buying.

*Parts only

A COMBINATION THAT CAN'T BE BEAT IN DRILLING

KEEP SPEED DOWN

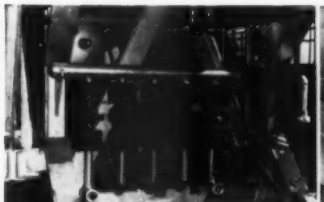


Photos taken on rig in Texas by special permission of the Wilshire Oil Company.

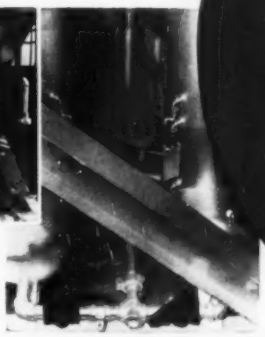
Nordstrom Merchrome Coated valves on mud lines

A GOOD CREW and NORDSTROM VALVES

Nordstrom valves on standpipe, surrounded by happy crew



Nordstrom valves on jet manifold



AT RIGHT: Nordstrom valves on air lines

ROCKWELL MANUFACTURING COMPANY 400 N. Lexington Avenue, Pittsburgh 8, Pa

Offices in All Principal Cities

How DuPont services can help you gain extra efficiency and economy in use of additives.

Du Pont not only makes a complete line of gasoline additives, but also offers comprehensive technical services to help you use them most effectively.

Our District Laboratories, for example, are in a position to suggest ways of cutting your antioxidant treating costs. And, since gasolines vary in their response to different antioxidants, the laboratory recommendations are based on a thorough evaluation of your own stocks.

We are also prepared to assist in such problems as overcoming the adverse effects of copper in gasoline. Or, perhaps you would like help in training blending plant personnel, setting up a safety program, or supervising tank entries. At-the-plant assistance in such work is an important part of the Du Pont representative's job.

The Du Pont service program, which includes assistance in research and marketing as well as manufacturing, is described in detail in the booklet, "Du Pont Services to the Petroleum Industry." If you do not already have a copy, write to the nearest district office, or contact your Du Pont representative.

Make DuPont the Source for All Your Gasoline Additives

TETRAETHYL LEAD COMPOUNDS
(Motor Mix . . . Aviation Mix) Supplied with medical, safety and technical services.

GASOLINE ANTIOXIDANTS
(Nos. 5, 6 & 22) To meet a wide range of gasoline stabilization problems.

METAL DEACTIVATOR
Its metal deactivating properties result in reduced antioxidant treating costs.

GASOLINE DYES
(Red, Blue, Yellow, Orange) Uniform—and can be mixed to obtain a wide range of shades.

DU PONT
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Better Things for Better Living . . . through Chemistry

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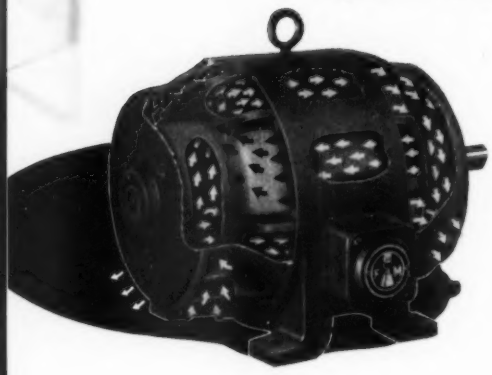
E. I. DU PONT DE NEMOURS & COMPANY (INC.)
Petroleum Chemicals Division • Wilmington 98, Delaware

District Offices: New York, N. Y. · Chicago, Ill. · Tulsa, Okla. · Houston, Texas · Los Angeles, Calif.

District Laboratories: Wilmington, Del. · Chicago, Ill. · Tulsa, Okla. · Houston, Texas · El Monte, Calif.

IN CANADA: Canadian Industries Limited—Toronto, Ont.—Montreal, Que.

We "Cooled Off" the Hot Spots for Longer Motor Life!



You'll find no hot spots in a Fairbanks-Morse Motor. Unique cross-flow ventilation assures uniform motor cooling . . . eliminates the hot spots that are so destructive to a stator insulation. Air is taken in at each end of the motor, flows through separated passageways across the stator core, and is exhausted simultaneously at opposite ends. This advantage is standard on all popular size Fairbanks-Morse General Purpose Motors.

Combine cross-flow ventilation with exclusive, indestructible Copperspun Rotors, protected, one-piece cast frame and rugged construction and you'll see why it pays to specify Fairbanks-Morse for your oil field motors. Fairbanks, Morse & Co., Chicago 5, Illinois.

FAIRBANKS-MORSE,
a name worth remembering

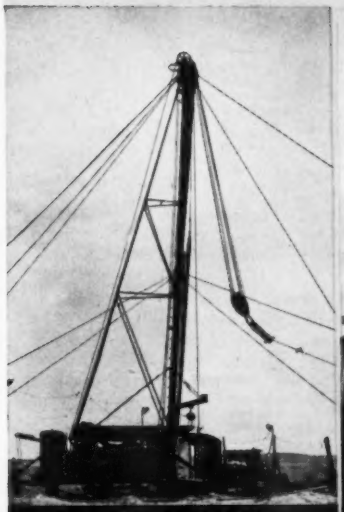
OIL FIELD EQUIPMENT • PUMPS • SCALES
ELECTRIC MOTORS • GENERATORS • LIGHT PLANTS • DIESEL, DUAL FUEL AND GASOLINE ENGINES • MAGNETOS

For better service and more economy

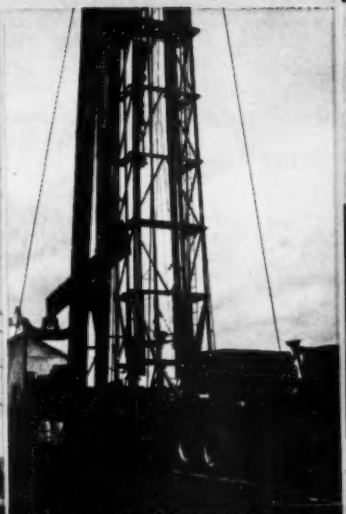
Order from a thousand and one

MACWHYTE WIRE ROPES

For rotary drilling



For cable tool drilling



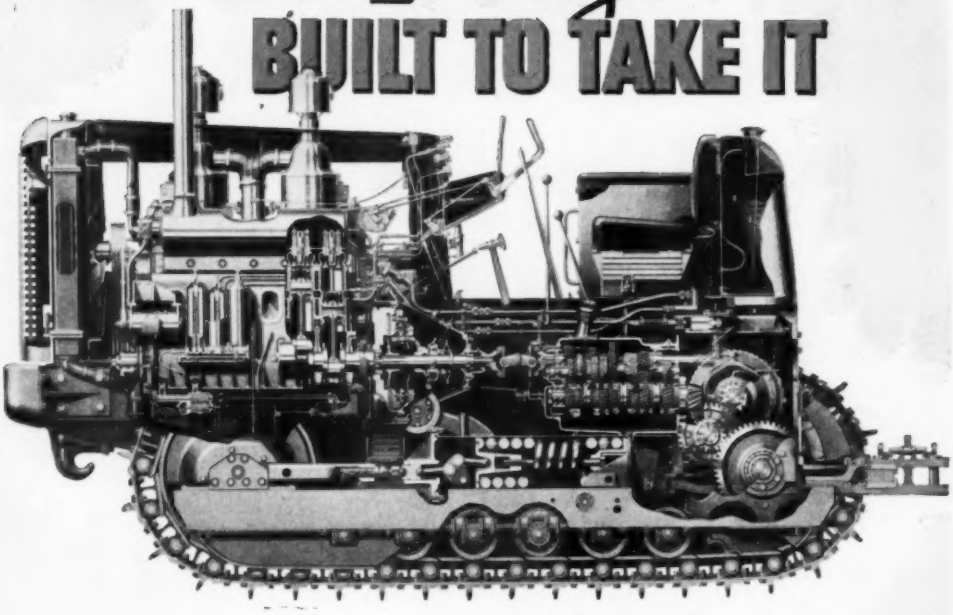
For well servicing

For pipe lines

You'll get maximum service from wire rope that has been specially designed for a special job. Over the years, ropes for all types of equipment in every field have been developed by Macwhyte. It will pay you to get Macwhyte Wire Rope that has been job-proved and engineered for your particular equipment. Recommendations are promptly available from Macwhyte distributors or Macwhyte Company.

MACWHYTE COMPANY, *2916 Fourteenth Avenue, Kenosha, Wisconsin. Manufacturers of Monarch Whyte Strand PREformed, Internally Lubricated Wire Rope, Atlas Braided Wire Rope Slings, Aircraft Cables and Assemblies, Monel Metal and Stainless Steel Wire Rope. Mill Depots: New York • Pittsburgh • Chicago • Minneapolis • Fort Worth • Portland • Seattle • San Francisco • Los Angeles. Catalog on request.*

Here's what WE mean by BUILT TO TAKE IT



The new Allis-Chalmers tractors are the toughest, strongest tractors ever built. Every part in each of the four models has ample size and strength to do its job — not a weak link nor a compromise anywhere.

And that's no accident! To bring you tractors like these . . . with the qualities you want . . . Allis-Chalmers built 'em completely new — from the ground up.

You can depend on them to take the loads, the jolts of today's jobs . . . because they are modern tractors designed for the most grueling operating conditions. They will more than measure up to your expectations!

Here are just a few of the many reasons why this NEWEST, FINEST TRACTOR LINE ON EARTH is *Built To Take It* . . . besides being easy to operate, easy to service and outstanding in performance. Your Allis-Chalmers dealer will gladly explain all these advantages . . . see him NOW.

- All-Steel Welded Construction
- More Power with Bigger Engines — Longer Engine Life
- More Weight, Greater Strength
- Extra Heavy Main Frames — No Extra Reinforcement Needed for Front-Mounted Equipment
- Long-Lasting, Large Diameter Clutches
- Double Reduction, Straddle-Mounted Final Drive Gears with Live Sprocket Shafts and Caged Bearings
- Positive Operating Track Release — Works in Oil on HD-9, HD-15, HD-20
- All New, Specially Designed Track Assembly
- Positive-Seal Truck Wheels, Support Rollers and Idlers — Mounted on Tapered Roller Bearing. 1,000-Hour Lubrication!

ALLIS-CHALMERS

TRACTOR DIVISION — MILWAUKEE 1, U. S. A.

The Newest, Finest Tractor Line on Earth!

40.26 drawbar hp.
11,250 lb.

70 drawbar hp.
18,500 lb.

* 102 drawbar hp.
27,850 lb.

Hydraulic Torque Converter Drive
175 net engine hp.
41,800 lb.

- DESIGNED FOR YOUR JOB
- BUILT TO "TAKE IT"
- EASY TO OPERATE
- EASY TO SERVICE

LINK-BELT Ball and Roller Bearings smooth the path of power

Lubrication fitting with pressure relief feature prevents excessive grease pressure.
The "housing sealed" feature fully protects and lubricates all moving surfaces.
Self-aligning—inner raceway is truly spherical, free to move in any direction without altering contact area with rollers. Full load capacity always assured with shaft deflection or misalignment.
Large grease reservoir prolongs lubrication intervals.
Sturdy, compact cast housing requires minimum support space.
Threaded end cover with two set-screws and fibre locking inserts holds bearing firmly in housing.
Long inner ring distributes bearing load over large shaft area.
Easily installed by slipping bearing onto shaft and clamping inner ring by tightening two set-screws in spring locking collar.
Seals effectively keep grease in, dirt out.
Slotted bolt holes facilitate mounting on supporting structure.
CUTAWAY OF SERIES 400 ROLLER BEARING PILLOW BLOCK

By any standard . . . **LINK-BELT Bearing Blocks offer strength plus economy**

POUND-FOR-POUND you can't beat the bearing strength and long life of Link-Belt Ball and Roller Bearings. Take the Series 400 Roller Bearing Pillow Block, for example. Built for shaft sizes from ¾ to 4 in., this bearing has an "average life" up to 100,000 hours . . . radial load ratings up to 61,000 pounds. A Link-Belt bearing specialist will help you apply any of the broad Link-Belt line. And you'll find complete engineering information in Data Book 2550.

LINK-BELT

BALL AND ROLLER BEARINGS

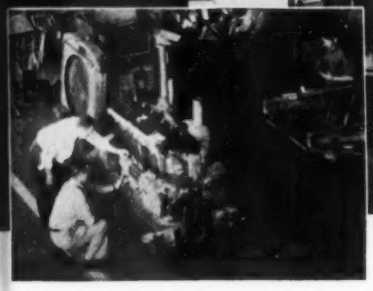
LINK-BELT COMPANY
Indianapolis 6, Dallas 1, Houston 1,
Los Angeles 33, Kansas City 8, Mo.,
New York 7, Toronto 8.
Distributors in all fields.

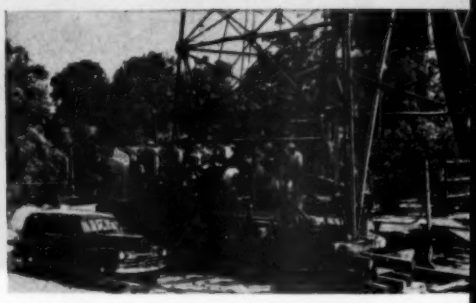
12,438

The Oil and Gas Journal, published Thursdays by The Petroleum Publishing Company. Entered as second-class matter September 1, 1910, at post office at Tulsa, Okla., under act of March 3, 1879. U. S. and foreign rates to the petroleum industry, $3 yearly. Copyright 1951.

Your strong right arm...

in time of need





BECAUSE of the vast defense mobilization program, material shortages and extra production demands have gripped the nation. They affect particularly the heavy industries and the distributors and users of their products. And huge as America's facilities have become in recent years, they still are not large enough to keep pace with both military and civilian needs.

Nevertheless, as an owner of "Caterpillar" products, you are among the more fortunate. Your "Cat" equipment has been built for long life and to withstand severe working conditions. What's more, it is backed by a dealer organization that is world-famous for experience, accessibility, mechanical facilities and field service to keep you going "come hell or high water."

Since World War II, the already large number of "Caterpillar" sales-and-service establishments has increased greatly. Also since that time, "Caterpillar" and its dealers have developed new techniques for restoring and extending the life of "Caterpillar" products. Today, in their own shops, "Caterpillar" dealers can *rebuild* a great many worn or damaged parts which formerly required completely new replacement. In short, every dealer is richly acquainted with scores of modern ways and means for keeping your machines in good working condition. You can help by doing this:

Take your maintenance problems to your "Caterpillar" dealer* BEFORE *parts are worn beyond repair

Remember that excessively worn parts can cause damage to mating parts; that track parts, pistons and liners, crankshafts, cylinder heads, radiators and other items usually can be salvaged. Your problems are your dealer's problems. Go see him today. He'll do everything in his power to keep your machines operating. Your combined efforts will be reflected in longer equipment life.

CATERPILLAR TRACTOR CO. • PEORIA, ILLINOIS

CATERPILLAR

REG. U. S. PAT. OFF.

DIESEL ENGINES
TRACTORS
MOTOR GRADERS
EARTHMOVING EQUIPMENT

It's new... so it's MARLEY!

MARLEY
Laminated Fan Cylinder
PATENT APPLIED FOR
THE MARLEY CO., INC.
KANSAS CITY KANSAS

Cooling Tower Fan Cylinders

that are entirely new, distinctive in design . . . are another major addition to Marley's long list of achievements in cooling tower advancement.

Laminated Fan Cylinders are the sturdiest ever applied to cooling towers. Built entirely of overlapping layers of redwood boards, they are structurally strong . . . uniformly strong at every point. No metal shape rings or clamp strips are needed; there is nothing to corrode, loosen or vibrate. Laminated Fan Cylinders are built of the same material as the towers they serve . . . built to last as long.

MODERNIZE ANY LARGE INDUCED DRAFT TOWER

Laminated Fan Cylinders will reduce maintenance time and upkeep expense on *any* large cooling tower. No painting, no replacing rusted metal parts — you check fan cylinders off the maintenance list when you install modern Laminated Fan Cylinders. Engineers have ordered many of these fan cylinders for replacement since Marley recently made them available.

also producers of
DOUBLE-FLOW TOWERS
CONVENTIONAL TOWERS
DRICOOLERS
NATURAL DRAFT TOWERS
SPRAY NOZZLES

For detailed information, call your Marley representative or write for LP-30a.

The Marley Company, Inc.
KANSAS CITY 15, KANSAS

MARLEY

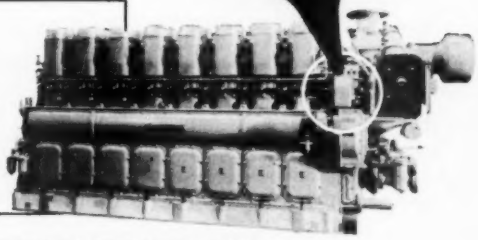
TOPS in Oil Pipe Line Pumping Power

Fuel flexibility, operating economy, continuous pumping station service that can't be interrupted by fuel shortages—these are the basic reasons why more and more oil transportation and pipe line companies are installing dual-fuel engines for pumping power at its best. Enterprise Dual Fuel Engines combine all these important advantages to provide highest engine efficiency at lowest power cost through three-way fuel flexibility:

1. **Handles any combination of gas and oil,** from full diesel to about 95% gas, 5% pilot oil. Change-over from one fuel to the other is smooth, positive and instantaneous through simplified controls.
2. **Burns Diesel, crude and residual fuels.** Many grades of properly prepared "heavy" fuels can be used, tapped directly from the line. No change in the basic fuel injection system is required.
3. **A wide variety of gas fuels are suitable,** including natural gas, butane or butane-propane mixture—whichever is available at lowest cost.

To get the most for your power dollar investment, write today for full information on these and other outstanding features of Enterprise Dual Fuel Engines.

ENTERPRISE
Dual Fuel Engines



Enterprise DEPENDABLE Diesels

Enterprise Diesels, Dual-Fuel and Spark Ignition Gas Engines are built in a wide range of models from 68 to 1755 HP, Generator sets to 1250 KW. Turbocharging available on most models.

ENTERPRISE ENGINE & MACHINERY CO.
A Subsidiary of General Metals Corporation
18th & Florida Streets, San Francisco 10, California
Offices in Principal Cities

Get a load of this

...FOR LONG ROPE SERVICE IN THE OIL FIELDS

When it's time to switch the wire line, be ready with another tough B & B rope designed for that particular job. Preformed Yellow Strand Rotary Lines have the stamina to cope with quick starts and stops, high speeds, heavy strings. In the same way Brodril Cable Tool Drilling Lines have the pronounced resiliency and stout abrasion-resistance needed for reaching deep pay zones. You can count on corresponding endurance in other B & B lines. To get a load of assistance specify Preformed Yellow Strand.

Broderick & Bascom Rope Co., St. Louis 15, Mo.

BRODERICK & BASCOM
Yellow Strand
PREFORMED WIRE ROPE

Houston Factory and Branch:
9350 Market Street Road

Los Angeles Branch:
3441 Hunter Street

San Francisco Branch:
899 Bryant Street

The Continental Supply Co.
Mid-Continent Distributors
Stores in All Active Fields

The McJunkin Supply Co.
Charleston, West Virginia

PRESSURE TIGHT WITHOUT LUBRICATION

- NEW TEFLON-SEAL STUFFING BOX
- CUTS METER MAINTENANCE
- ELIMINATES LEAKS
- ELIMINATES SHAFT FREEZING

STANDARD IN
1800 PSI
ORIFICE METERS

Teflon-Seal Stuffing Boxes have been operating for more than two years without servicing in thousands of orifice meter installations! Applications such as sour gas, wet gas, caustic solutions — almost every conceivable service — have failed to impair meter operation. Maintenance problems are drastically reduced or eliminated!

The Teflon-Seal bearing is pressure-sealing around a precision made, centerless-ground Monel metal shaft, *without grease and with minimum friction.* All other stuffing box parts are corrosion resistant stainless steel. The Teflon-Seal Stuffing Box is suitable for ambient meter temperatures to 150°F. and working pressures to 1800 psi. Units are adaptable to older types of orifice meters now in service.

Here is another example of American Meter Company's policy of constant product improvement to uphold a century-old tradition of "*Sustained Accuracy at Lower Cost.*"

See our display, booth 101-S, Sixth National Instrument Exhibit, Sam Houston Coliseum, Houston, Texas, September 10-14.

PROPERTIES OF TEFLON

Teflon (polytetrafluoroethylene) is a synthetic polymer with the following properties: low coefficient of friction — zero water absorption — high impact strength — toughness — form stability — and exceptional chemical inertness. It retains strength at temperatures from —100°F. to 550°F. and does not stick or "weld" to other materials. It resists the attack of all known solvents except molten alkali metals, with no change in weight or properties.

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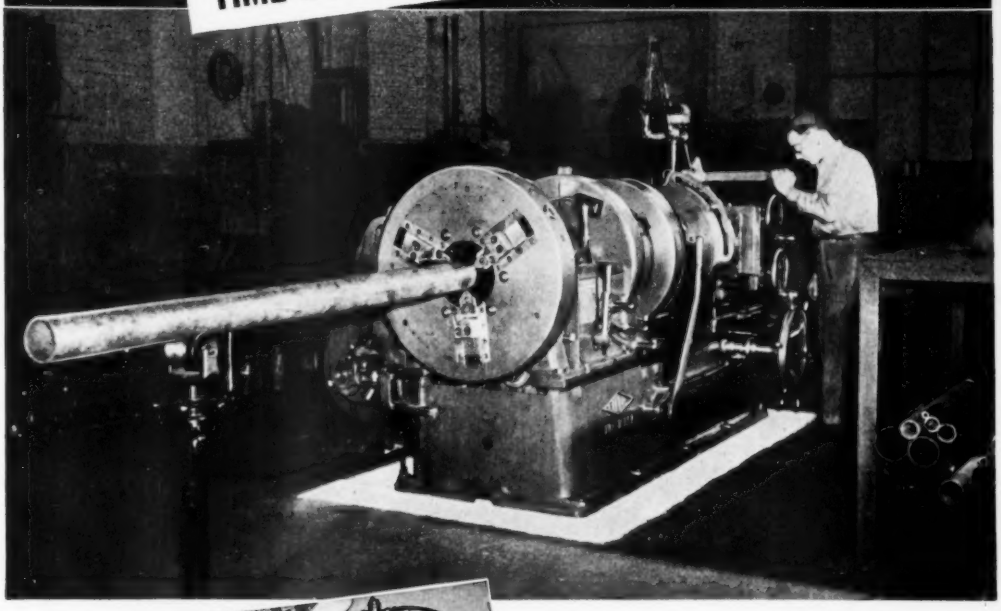
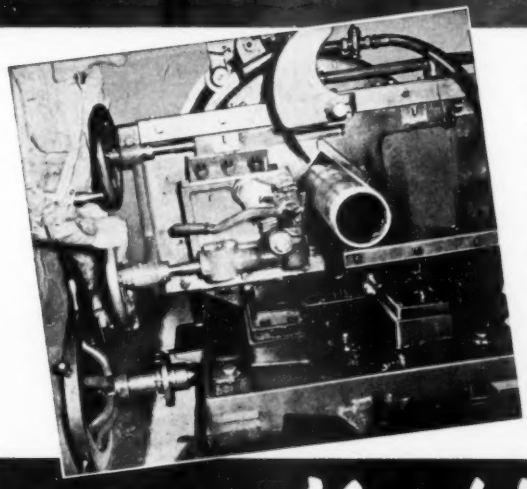
AMERICAN METER COMPANY

VERSATILITY

Saves TIME & MONEY in Maintenance Shops





Photographs show a Landis Pipe Threading Machine installation in a Job Shop of the New York Central Railroad. This shop, located at Weehawken, New Jersey, operates as a Marine Repair Shop handling maintenance for tugs, barges, lighters, etc. Illustrations show wrought iron pipe being cut off after reaming and threading. Standard pipe threads are cut 1½" long on the 4" pipe, using a cutting speed of 25 surface feet per minute. This machine is also used for cutting boiler tubes to length.

The wide diametrical range of the die heads and the use of patented tangential pipe chasers gives these machines a versatility invaluable in maintenance work. For example, the 6" Landis Pipe Threading Machine illustrated threads all pipe sizes from 1" to 6", inclusive. Size adjustment of the die head is simple and quick. Chasers need not be changed except for threads of a different pitch, form, or taper. Chasers are interchangeable and need only be replaced singly as needed. Tangential cutting action reduces wear, and chasers can be reground to use over 80% of their length. Write for Bulletin C-61.

LANDIS *Machine* COMPANY

WAYNESBORO · PENNSYLVANIA · U. S. A.

Represented in the Domestic Oil Fields by: Colcord-Wright Machinery & Supply Co., St. Louis, Mo.; C. J. Harter Machinery, Houston, Texas; Frederic-Baker Co., New Orleans, La.; Moore Machinery Co., Los Angeles and San Francisco, Calif.; Hendrie & Bolthoff Mfg. & Supply Co., Denver, Colo.

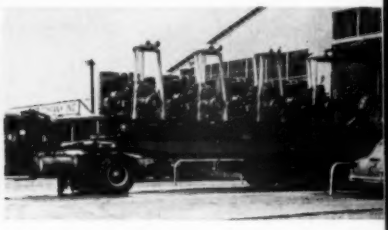
BREWSTER N-12

For Deepest Drilling

Brewster's "Golden Rig," the N-12 is powerful and rugged... yet it's easy to move.

It has 8 drum speeds, 8 rotary speeds, two 850 h.p. pump drive sheaves and it is powered with four 400 horsepower engines.

After a year in the field the "Golden Rig" has proven the value of its "Extra Beef."



Drum Speed	Line Speed	Line Pull	Rotary Speed
34.4 RPM	285 ft./min.	126,000#	56.2
50.1	416	89,000#	83.5
72.6	603	59,000#	122.0
105.9	880	42,000#	177.0
135.5	1,126	31,000#	162.0
197.8	1,644	22,700#	236.0
286.5	2,381	15,300#	341.0
418.2	3,476	10,700#	500.0

The N-12 is easily moved. Penrod uses only standard transportation equipment for hauling the three major components of the rig from one location to another.

Penrod's "Golden Rig" in McElroy Ranch field, Texas, drilling its third deep well.

"I Like the Extra Beef in Brewster's N-12"

Claude Roberson,
Drilling Superintendent
Penrod Drilling Company

"Our Brewster N-12 has drilled two deep tests and is on its third well. In its first year of operation we have found out that it has plenty of extra beef under that tough hide. That's why we haven't had to shut it down a single day for maintenance."

"BEST RIG I'VE EVER RUN"

"My N-12 has plenty of power to pull a long string out of the hole in a hurry and when it's drilling, there's no vibration, no matter how deep or how big the hole."

J. D. Norris,
Tool Pusher
Penrod Drilling Company

Write today for the new Brewster catalog, giving full details on Brewster drilling equipment.

SUPPLY COMPANIES

Apex Equipment Company
Bovaird Supply Company
Industrial Supply Company
Murray Brooks, Inc.
Reams Supply Company

IN CANADA: Rocky Mountain Supply Co.
Direct and through recognized export dealers

BREWSTER DRILLING EQUIPMENT

THE BREWSTER COMPANY, INC.
Shreveport, Louisiana

ANNIVERSARY OF BREWSTER'S GOLDEN RIG

Brewster rang up the curtain in July, 1950, on their new "Golden Rig," the N-12 drawworks for deepest drilling. In this advertisement is a first hand report from the drilling superintendent and the man who has been operating the first "Golden Rig" for the past year.

Since 1910 Manufacturers of fine Drilling Equipment

CHASE ANTIMONIAL ADMIRALTY *(A patented alloy)*

If you want heat exchanger tubes that will stand up for years under tough conditions, remember... Chase Antimonial Admiralty* Heat Exchanger Tubes last longer! It's the antimony that does it!

These great heat exchanger tubes have enough antimony to resist dezincification. And antimony will not weaken the tube. The metal starts with the right grain structure and retains it... it stays tough and withstands the stresses of heavy duty assignments.

You'll do better with Chase Antimonial Admiralty Heat Exchanger Tubes! Send coupon for FREE Book.

*U.S. Pat. No. 2,061,921

CHASE WAREHOUSE STOCKS:
NEW YORK, BALTIMORE,
NEW ORLEANS, LOS ANGELES
Also carried by
Vinson Supply Co., Tulsa,
Standard Brass & Mfg. Co., Houston.

FREE CHASE BOOK discusses corrosion problems and selection of proper alloy for condenser and heat exchanger tubes.

Chase Brass & Copper Co., Dept. OGJ 751a
Waterbury 20, Conn.
Please send me your free book on Condenser and Heat Exchanger Tubes.

Name _____
Firm _____
Position _____
Address _____
City _____ **State** _____

Chase **BRASS & COPPER**

WATERBURY 20, CONNECTICUT • SUBSIDIARY OF KENNECOTT COPPER CORPORATION

• The Nation's Headquarters for Brass & Copper

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Atlanta	Cleveland	Indianapolis	Newark	Providence	Waterbury
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Boston	Denver†	Los Angeles	New York	St. Louis	(Sales office only)
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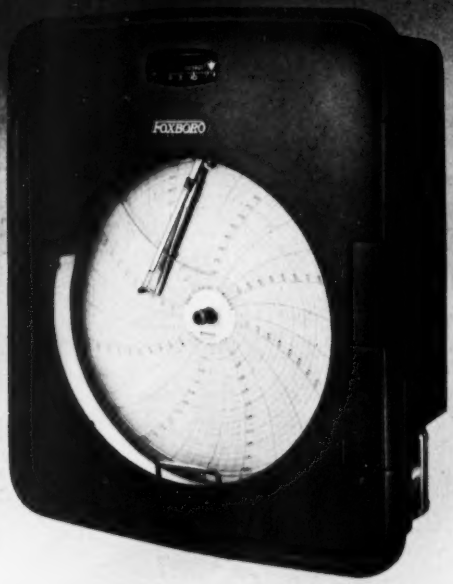
CHASE 75th ANNIVERSARY 1876 1951

better measurement and control of

PRESSURE

From vacuum to 80,000 psi . . .



Whether the critical pressure of your process is full vacuum, 80,000 psi, or any range between . . . the complete diversity and engineering quality of Foxboro Instruments provide a means to measure or control it with highest accuracy and reliability. Add to this an unequaled experience in applying instruments to solve processing problems, and you have the reason for Industry's preference for Foxboro Pressure Instrumentation.

INDICATORS • RECORDERS • CONTROLLERS
TRANSMISSION SYSTEMS • CONTROLLED VALVES

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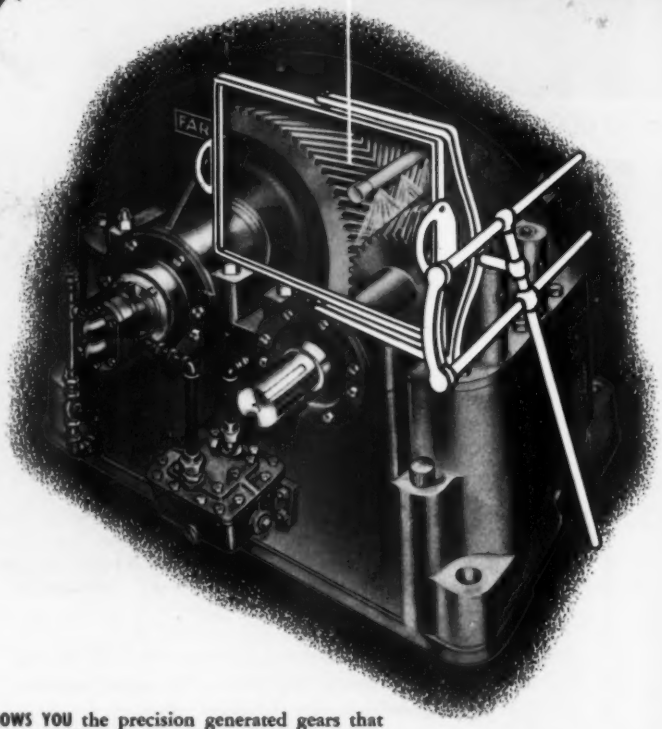
For over 40 years, specialists in the measurement and control of temperature, pressure, flow, liquid level, humidity . . .

THE FOXBORO COMPANY • FOXBORO, MASSACHUSETTS, U.S.A.

This X-ray View Shows You—

WHY NO FARREL® SPEED INCREASER HAS EVER FAILED IN PIPELINE PUMPING SERVICE



IT SHOWS YOU the precision generated gears that operate quietly and efficiently through long years of service . . . the completely self-contained circulating oil system that virtually puts power on velvet . . . the extra large precision-ground shafts . . . the oversize, accurately finished bearings . . . and the exceptionally rigid housing.

IT DOES NOT SHOW YOU the knowledge which has been accumulated by Farrel engineers in the making of thousands of gear units for oil field, industrial and marine service . . . the data obtained from customer service reports . . . or the extensive tests conducted by the company's research department—all of which have contributed to the reputation these units have for providing long, *trouble-free performance with minimum maintenance.*

BUT WHY NOT TAKE A MORE THOROUGH LOOK . . . first, at our bulletin 448-A, which describes these speed increasers in detail . . . and, then, at some units in actual operation. We shall be glad to send you a copy of the bulletin, without cost or obligation . . . and, also, tell you where there are some Farrel speed increasers installed in your locality.

FARREL-BIRMINGHAM COMPANY, INC., ANSONIA, CONN.
Plants: Ansonia and Derby, Conn., Buffalo, N. Y.
Sales Offices: Ansonia, Buffalo, New York, Boston, Pittsburgh, Akron, Cleveland, Detroit, Chicago, Portland (Oregon), Los Angeles, Salt Lake City, New Orleans

OIL FIELD REPRESENTATIVES:
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FB-678

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1901-1951

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From pipe stills to fluid cats...with Jersey!

Various Jersey Standard affiliates have been on Kellogg's customer ledger for twenty-five years. In that time, Kellogg has built a score and more of process units for the New Jersey, Maryland, Louisiana and Aruba refineries of Jersey affiliates.

Process development also found these two companies working along the same paths, a fact which culminated in Kellogg being entrusted with the erection of the world's first Fluid catalytic cracker...in 1941 at Esso Standard Oil Company's Baton Rouge Refinery.

In the last decade, following this historic development, Kellogg has erected for Jersey Standard and its affiliates —seven more Fluid "cats", the largest hydroformer in the world, a hydrogenation unit, combination thermal units, delayed coker, thermal reformers and propane and phenol processing plants... on three continents...units capable of processing almost 500,000 BPD of petroleum products.

THE M. W. KELLOGG COMPANY

A SUBSIDIARY OF PULLMAN INCORPORATED

for fifty years an integral part of processing history

NEW YORK JERSEY CITY LOS ANGELES TULSA HOUSTON TORONTO LONDON PARIS

Portrait at

This year is Kellogg's fiftieth of service to industry. At this time naturally, as a group of men—known collectively to the modern business world as The M. W. Kellogg Company—we can think back nostalgically. We can remember the chimney stacks

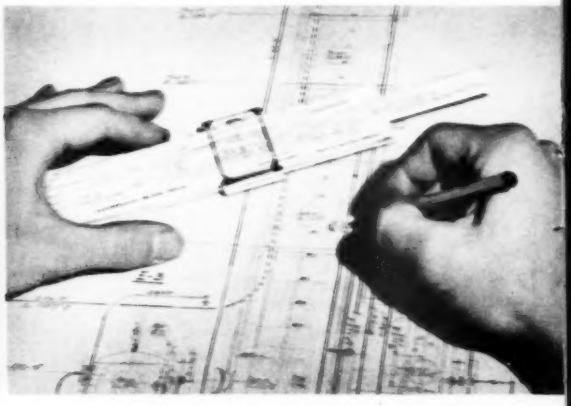
"Getting the Most out of Talent"

Preceding camera "portraits" of M. W. Kellogg today, appearing in this publication, have guided the regular reader through the major research and development phases of Kellogg operation, through Process Engineering, and through the basic steps of Design Engineering.

This month, the camera focuses on a few of the many special groups and unique devices that Kellogg utilizes to make the efforts of its design engineers more efficient.

1. *FOR EVERY SPECIFIC PHASE* of design engineering there is a complete matching group of specializing engineers. This view of a section of the *Heat Transfer Division* shows only the "figure men"—engineers specifying type of exchangers and general design limitations. Detail engineering is done elsewhere. Another group handles design of electrical systems and instrumentation exclusively.

4. *USUALLY ASSOCIATED* with wages, hours and cost accounting, these modern punch card machines serve the engineering departments in a slightly different manner. Through keeping continuous records of engineering time "by type of job" rather than "by job", realistic budgets are achieved of engineering time required to perform any of the hundreds of engineering tasks comprising a refinery project.



5. *BUT MAN AND BRAIN POWER* to do these supporting tasks, that make design engineers more efficient, are not the only "extras" present in the organization. Specialized and unique tools are created, and made available to design engineers. This slide rule was created by Kellogg engineers to speed up the computation of vapor and liquid flow through process piping of various diameters under varying operating conditions.

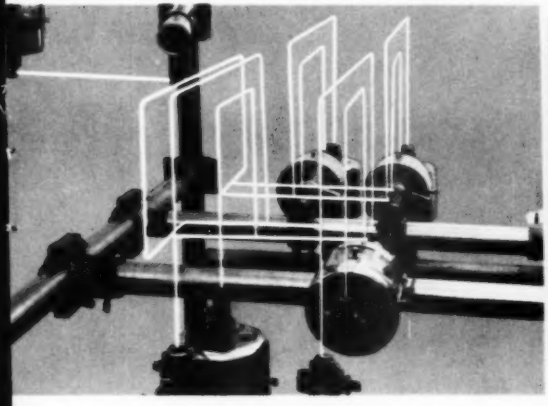
Fifty... no. 6

M. W. KELLOGG
1901 1951
50th Anniversary

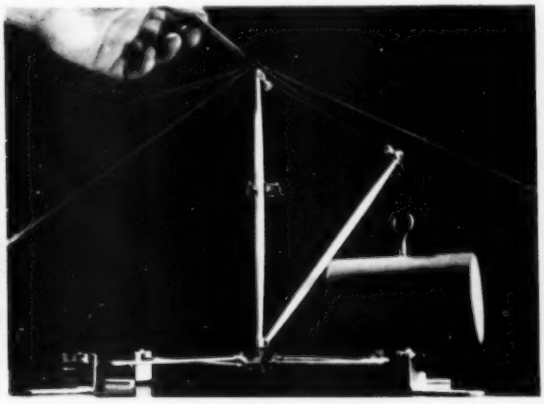
we built in 1901 . . . the first crude vessels for oil refiners in the 'teens . . . our first combination unit. The forty-odd Fluid cat crackers built in these years. But, after all, The M. W. Kellogg Company is only a factor as it is able to serve industry today. For that reason, we are presenting this series of monthly camera studies which document our belief that a truly integrated organization can better serve industry to achieve greater earning power. This is No. 6 in the series.

2. *AS REFLETE WITH DESIGN* engineering talent as Kellogg is, the organization's abilities are equally dependent on many other technicians. Of major importance among these is the *Estimating Engineering Staff*. Besides estimating costs of new projects, this group serves refiners through its trend charts of the major cost ingredients of refinery projects. These pinpoint for design engineers the best potentials for economies.

3. *CLOSELY ALLIED TO ESTIMATING* is the engineering job of *Scheduling*—not only of the engineering work itself, but of purchasing, fabrication and construction as well. Experience of Kellogg's scheduling personnel is measured in decades. This experience stands customers in good stead in the setting up of realistic schedules for completion of a project at the earliest possible date consistent with expenditure limitations.



6. *THIS MODEL TESTER* for piping systems employs special Kellogg-conceived electrical measuring heads. The device permits the rapid and accurate calculation of pipe stress problems in a matter of minutes—problems which would otherwise involve the solution of as many as 50 to 60 simultaneous equations, virtually "impossible" mathematically from the standpoint of time consumption.

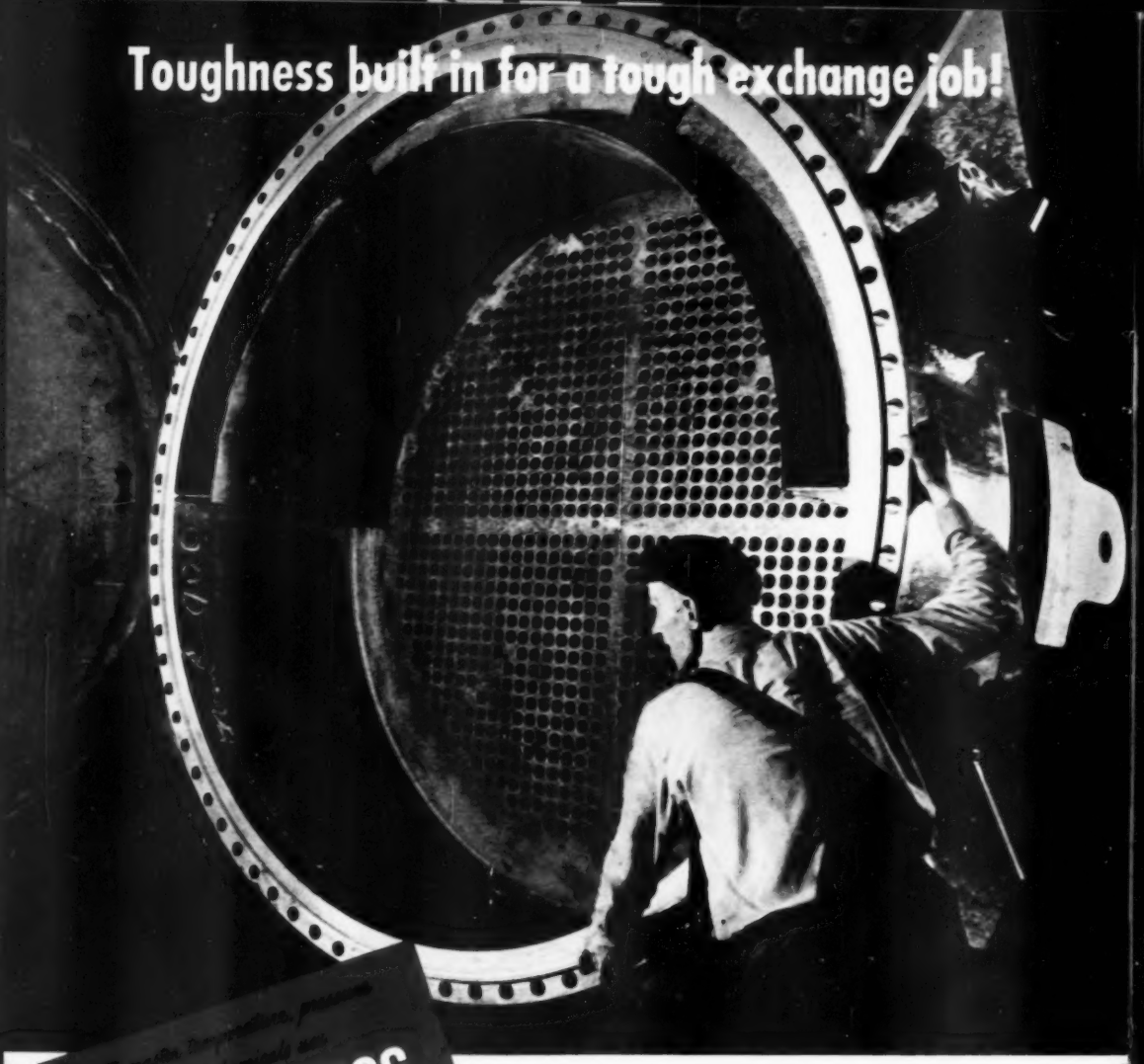


7. *ANOTHER SPECIAL AID* is this guy derrick model equipped with strain gauges. This tool permits engineers, in making plot plans and issuing field fabrication instructions, to check *in advance* the exact methods required to lift vessels safely into position. There are perhaps a score of such useful "gadgets" scattered about the engineering floors. Of course, they save hours of time, but, much more important, they permit true accuracy in planning.

NEXT MONTH

. . . in the seventh in this series of camera studies of M. W. Kellogg today . . . you will review the important role that Technical Data and Standards play in the engineering and procurement functions.

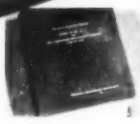
Toughness built in for a tough exchange job!



M. W. KELLOGG

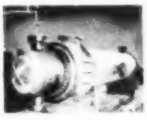
This 8 foot diameter tube sheet is for a recycle-catalyst cooler on a giant cat-cracker. Tons of erosive powder will pour through the cooler's tubes in minutes as it controls regenerated catalyst temperature. Kellogg's exclusive fabricating techniques really pay off in equipment for such tough processing jobs.

Pressure Vessels
Vacuum Vessels
Fractionating Columns
Drums and Shells
Heat Exchangers
Process Piping
Hi-pressure—Hi-temp Power Piping
Bends and Headers
Giant One-Piece Bends
Forged and Welded Fittings
Radial Brick Chimneys



Continuing Basic Study of heat exchange by Kellogg development groups over 20 years has produced unduplicated design data.

Shop Layout Craftsmen have had experience on all types of heat exchangers, from marine condensers to jet engine combustion chambers.



Rigid Quality Control is maintained by inspectors reporting directly to *Shop Management* rather than to *Production* executives.

Extensive Shop Facilities, from plate forming to stud threading, permit *complete* fabrication of any type heat exchanger.

Special Shop Techniques—the component parts of each exchanger are fabricated as a production unit, building in the advantages of "tailor-made" fit.

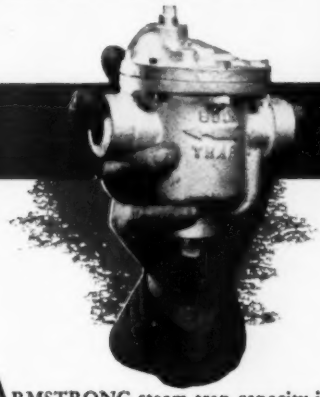
NEWS FOR OPERATORS IN WESTERN CANADA!

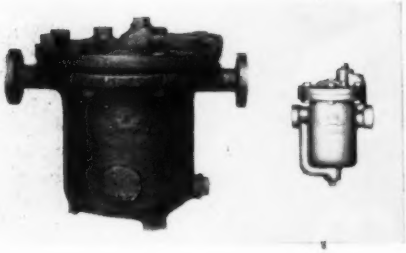
The Canadian Kellogg Company Ltd. has established complete shop facilities for the fabrication of all types of piping at **EDMONTON**, Alberta. Inquire directly or through any Kellogg or Canadian Kellogg office.

The M. W. Kellogg Company *(A Subsidiary of Pullman Incorporated)* **New York, Jersey City, Los Angeles, Tulsa, Houston, Toronto, London, Paris**

FOR BIG TRAP CAPACITY IN A SMALL PACKAGE ...buy Armstrongs

SIZE FOR SIZE THEY GIVE YOU MORE





FROM THE RIDICULOUS TO THE SUBLIME . . . The monstrosity on the left is a steam trap once manufactured in Germany. It weighs 116 lbs. but has no more capacity than the 10½ lb. Armstrong trap on the right. All of which is a means of focussing your attention on the importance of a steam trap leverage system. The size of the big trap is necessary due to its crude-by-comparison leverage design.

ARMSTRONG steam trap capacity is a bargain size for size because of the patented leverage system. In an Armstrong trap for 100 psig, leverage is higher than in one for, say, 15 psig. Thus, a larger valve can be opened than would be possible if the leverage was the same for all pressures.

That sounds simple, but isn't. If higher leverage is secured with a longer lever arm, a bigger trap body is needed. That's the trouble with the elephant shown at the left. Also the design must permit the valve to open *wide* or it will restrict the orifice, reducing capacity. *Armstrong's design answers these problems better than any other design.*

P. S. When comparing traps be sure capacities are based (as are Armstrongs) on *actual* tests with condensate at steam temperature. No other basis is reliable. ARMSTRONG MACHINE WORKS, 868 Maple St., Three Rivers, Michigan.

SEE OUR CATALOG IN SWEET'S

The 36-PAGE STEAM TRAP BOOK gives dimensions, weights and *actual* capacities of Armstrong traps. Write for a copy or Call your local Armstrong Representative.

ARMSTRONG STEAM TRAPS

SUPPLYING WEST TEXAS AND NEW MEXICO

- MIDLAND
- ABILENE
- EUNICE
- FARMINGTON
- BROWNFIELD
- HOBBS
- KERMIT
- ODESSA
- SNYDER
- SUNDOWN

In West Texas and New Mexico, Mid-Continent Supply Company has consistently expanded its stores and services to assure a readily available source of the finest in equipment and supplies to meet any oil-field requirement. You'll find these Mid-Continent stores operating "Around-the-Clock" . . . and staffed by experienced men who have the "know-how" to give you unexcelled specialized service. Make these stores, topped by the familiar blue neon oil-spouting derrick, your supply headquarters.

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AIRCO HARDFACE-LIFTING

makes old parts new... and new parts better

With today's delays in replacements, dollars offer less and less protection when tools or equipment wear out. No chance of cut-backs, or loss of day-to-day production, if wearing areas are fully protected with Airco Hardfacing Alloys... new parts and old stay on the job longer—even at peak production.

No matter what the part, or tool ... fishtail bits ... roller bits ... core heads ... wall scraper blades ... drag type drilling bits ... their life is extended many times by using Airco Tung Tube.

There are more than fifteen types of Airco Hardfacing rods available ... for protection from every type of wear. Two other alloys widely used in oil field service are Aircoloy 1 and 6, for hardfacing equipment to resist corrosion and temperatures above 700°F. Both alloys have been built to resist abrasion at high temperatures.

Wear is a serious problem in your operations! It will pay you to investigate Airco Hardfacing Alloys. An Airco representative will be glad to give you complete information. Get in touch with your local Airco office today.

a few AIRCO hardfacing alloys

AIRCOLOY® No. 1

A non-ferrous, hardfacing alloy consisting of cobalt, chromium and tungsten ... excellent corrosion resistance ... retains hardness and wear resistance even at red heat ... cold hardness of 53 to 57 on Rockwell "C" scale. May be used wherever heat, abrasion and corrosion are involved. Aircoloy No. 1 is furnished bare for oxyacetylene application and coated for electric arc welding.

AIRCOLOY® No. 6

Excellent corrosion resistance ... high impact and good wear resistance with some degree of ductility ... retains hardness and wear resistance at red heat ... cold hardness of 43 to 47 Rockwell "C". May be used wherever heat, impact, abrasion and corrosion are involved.

AIRCOLITE No. 59

These cast alloy rods are recommended for application wherever abrasion resistance is particularly important. Deposits acquire a high polish in service, and maintain their high hardness at temperatures up to 800° F. Applied either electrically or by gas process. Deposits test from 54-59 on Rockwell "C" scale.

★ ★ ★

Air Reduction supplies Oxygen, Acetylene and other industrial gases ... Calcium Carbide ... and a complete line of gas cutting machines, gas welding apparatus and supplies, plus arc welders, electrodes and accessories. Ask us about anything pertaining to gas welding and cutting and arc welding ... we'll be glad to help you.

AIR REDUCTION MAGNOLIA COMPANY

AIRCO

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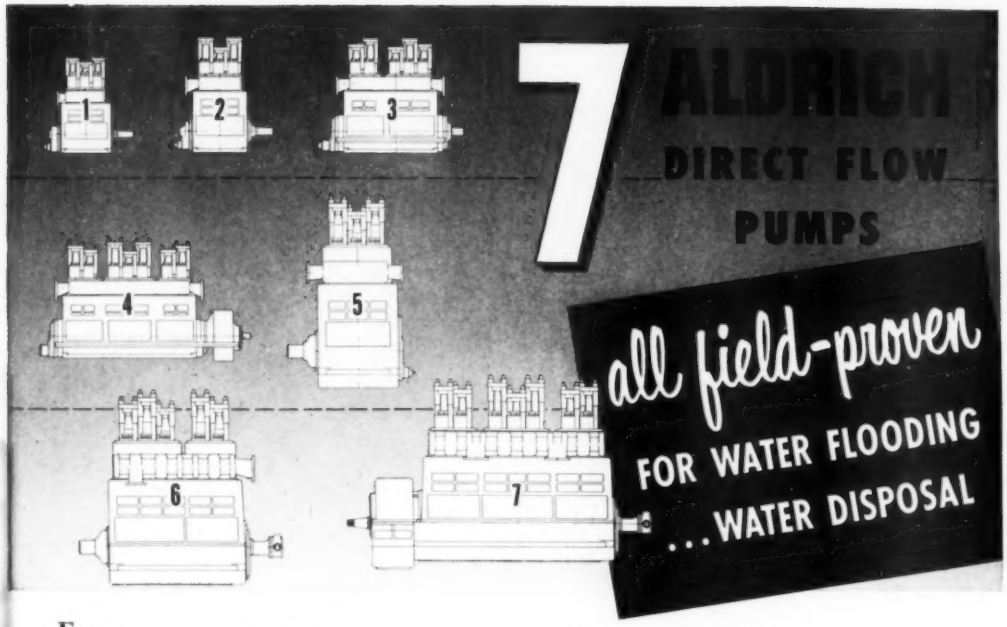
Southwestern Headquarters for Oxygen, Acetylene and Other Gases ... Carbide ... Gas Welding and Cutting Machines, Apparatus and Supplies ... Arc Welders, Electrodes and Accessories



Every Aldrich Direct Flow Pump shown here is operating on present-day water flood projects. The growing number of Aldrich Pumps at work on water flooding or water disposal is proof of Aldrich's qualifications to take care of your requirements—regardless of volume or pressure needed.

Note these reasons why you can consider Aldrich Direct Flow Pumps specially "designed-for-the-job":

- Reduced space between valves affords higher volumetric efficiency.
- Among 3-, 5- and 7-plunger units of the same stroke size: all wearing parts are interchangeable, and a choice of large or small fluid-ends affords a wide range of plunger selection and makes it possible to change plunger size with minimum investment in new parts.
- Operating speeds have been increased—resulting in greater volume and higher pressure from a lighter, more compact pump.
- Drive by direct connection to synchronous engine type, slow speed motor is available, if desired; and all units feature low engine mounting.
- Aldrich "KOSMOS" Porcelain Plungers and valves made of stainless steel or other special material are available to keep corrosion, wear and maintenance time—*down!*

Contact your nearest Aldrich Representative . . . or write us direct for information. Data Sheets are always available on request.

(1) 2⅛" x 3" Triplex..... 500 rpm
2,360 bbl per day.....1100 psi

(2) 1¾" x 5" Triplex..... 320 rpm
1,540 bbl per day.....2500 psi

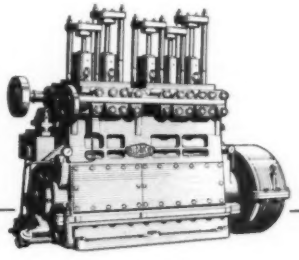
(3) 3¼" x 5" Quintuplex..... 360 rpm
11,100 bbl per day..... 713 psi

(4) 2⅞" x 5" Septuplex..... 375 rpm
11,900 bbl per day..... 910 psi

(5) 4" x 6" Triplex..... 277 rpm
8,720 bbl per day.....1545 psi

(6) 2⅛" x 6" Quintuplex..... 250 rpm
3,160 bbl per day.....5400 psi

(7) 3½" x 6" Septuplex..... 250 rpm
15,000 bbl per day.....2020 psi



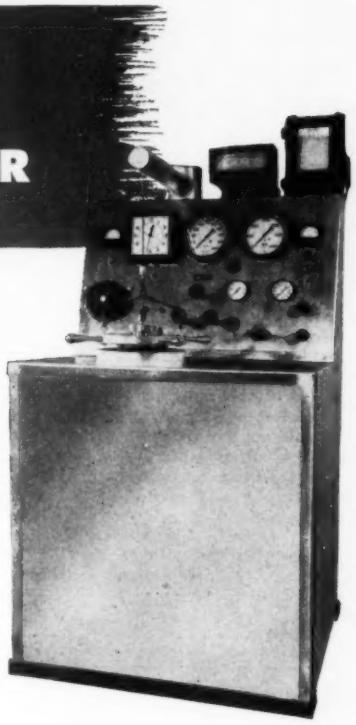
THE ALDRICH PUMP COMPANY

9 GORDON STREET · ALLENTOWN, PENNSYLVANIA

...Originators of the Direct Flow Pump

Representatives: P. H. Arden, P. O. Box 185, Glenview, Ill. • Bushnell Controls & Equipment Co., 3929 W. Jefferson Blvd., Los Angeles 16, Calif. • L. T. Gibbs, 509 Petroleum Bldg., Tulsa 3, Okla. • R. B. Moore Supply Co., Inc., Bolivar, N. Y. • Power Specialty Co., 2000 Kipling St., Houston 6, Texas • Reeves & Skinner Machinery Co., 2211 Olive St., St. Louis 3, Mo. Stearns-Roger Manufacturing Co., 1720 California St., Denver 2, Colo. • Export Sales: Petroleum Machinery Corp., 30 Rockefeller Plaza, New York 20, N. Y. • Birmingham • Boston Buffalo • Cincinnati • Cleveland • Detroit • Duluth • Jacksonville • Omaha • Philadelphia • Pittsburgh • Portland, Ore. • Richmond, Va. • San Francisco • Seattle • Spokane, Wash. • Syracuse

R. S. CEMENT CONSISTOMETER



CEMENT MAY BE TESTED

TO 400° F AND 20,000 PSI

TESTS SETTING TIME AND UNIFORMITY OF CEMENT

The R. S. Consistometer permits measurements of cement under temperature and pressures which simulate actual conditions met during oil well cementing operations. Cement samples are subjected to test conditions as specified by API Code 32 for plotting thickening versus time. Control panel contains valves, pressure gages, electric timer, temperature controls and indicating voltmeters. The pyrometer and recording voltmeter are located on the wall panel. Pressure is produced by a hydraulic pump mounted within the stainless steel cabinet together with the vertical steel test cylinder. Heat is supplied by a 1500 watt internal heater with variable transformer control.

Write for complete description. Ask for bulletin 50.

CENCO

CENTRAL SCIENTIFIC COMPANY
CHICAGO

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REFINERY SUPPLY COMPANY

Laboratory Apparatus and Supplies — *Oil and Gas Testing Equipment*

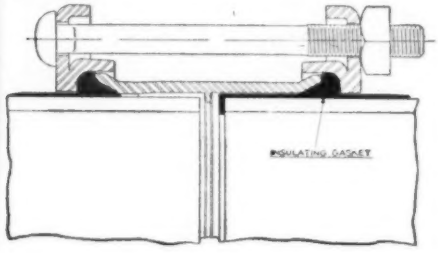
621-23 E. 4th St. Tulsa 3, Oklahoma

Low-cost, flexible insulating joint is simple to install

Where it is desirable to sectionalize a main for the application of electrolytic protection—or wherever insulating joints are indicated—Dresser Insulating Couplings, Style 39, provide ultimate protection at lower cost. There is no exact pipe fitting required and the joint itself costs but a fraction of the cost of more cumbersome insulating methods.

An additional advantage is that Style 39's with pipe stop bead removed can be cut into existing mains with a minimum of trouble and expense. Gaskets are of special rubber compound, as shown in cross-section drawing, or with protective plastic skirt where line contents might affect rubber compounds.

Sizes ½" through 30" and up. Also reducing sizes for going from steel to CIP.



Dresser ZIPCOATS* complete insulating joint protection... Easy and safe to install

Installed in 1/10 the time it takes to coat a joint, ZIPCOATS give sure protection, superlative dielectric strength. Simply zip them up like a jacket. There's no flame; no heating, hauling or messy application of hot stuff; no danger from fumes or burns. Three types: for insulating joints and for the straight run of pipe, including welds. *Write for literature.*

*ZIPCOAT is a Trademark of Dresser Manufacturing Division

Fast bonding. Preformed Dresser Bonds and 5-second chemical welding method make homogeneous weld area, eliminate surface contact variables. Save up to 50% of cost of bonding. Compact kit of preformed bonds includes all materials needed for installing.

DRESSER

MANUFACTURING DIVISION

Headquarters: 59 Fisher Ave., Bradford, Pa. (One of the Dresser Industries). Sales Offices: New York, Philadelphia, Chicago, Houston, San Francisco. In Canada: 629 Adelaide Street, W., Toronto, Ontario.

For Most Efficient Oil Field Cooling!

HC
HORIZONTAL CORE
COOLING and CONDENSING
UNITS BY **YOUNG**

Young "HC" Units are specially suited for large capacity cooling where water is at a premium. In fact, the inclosed system design makes them easily adaptable to water, oil and gas cooling, steam and vapor condensing *in any combination*. "HC"s combine the efficiency of vertical air discharge, the space savings of compact Young design, and the versatility and operating economy of multiple unit combinations. Water cooling capacities range from 550,000 to 11,000,000 Btu per hour; oil cooling from 168,000 to 3,600,000 Btu per hour. See your Young Representative or write for details.

YOUNG

Heat Transfer Products for Automotive and Industrial Applications.

Young Quality
T. M. Reg. U.S. Pat. Off.

Heating, Cooling, Air Conditioning Products for Home and Industry.

YOUNG RADIATOR COMPANY
Dept. 201-G • RACINE, WISCONSIN
Factories at Racine, Wisconsin and Mattoon, Illinois

OIL FIELD DISTRIBUTORS:
TULSA: J. R. Meek Company, 1341 S. Boston St., Rm. 109
LOS ANGELES: Flournoy & Everett Inc., 5043 Santa Fe Ave.
MUSKEGON: Harold J. Young, 206 Montgomery Bldg.

YOUNG RADIATOR COMPANY
Dept. 201-G, Racine, Wisconsin

Please send me more information about your line of "HC" Cooling and Condensing Units, including Catalog No. 550.

Our particular requirements include_____

_____

Name_____

Company_____

Address_____

City_____ Zone____ State_____

√RESEARCH

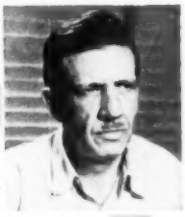
Continuing research in field and laboratory gives Independent's clients the benefit of the most advanced techniques and equipment . . . thoroughly proven.

√RESPONSIBILITY

Eighteen years of progress and client satisfaction give evidence of high professional standing and consistently reliable performance.

√REINTERPRETATION

Review interpretation service gives Independent's clients the extra value often available through experienced re-analysis of previously completed survey data.



F. M. Floyd, a key member of Independent's research staff, received his Electrical Engineering degree from Oklahoma University. Mr. Floyd's 23 years' experience servicing Independent's clients includes work in both field and laboratory.

Independent's record of service to a long list of important oil producers merits your confidence.

POINTING THE WAY FOR THE DRILL

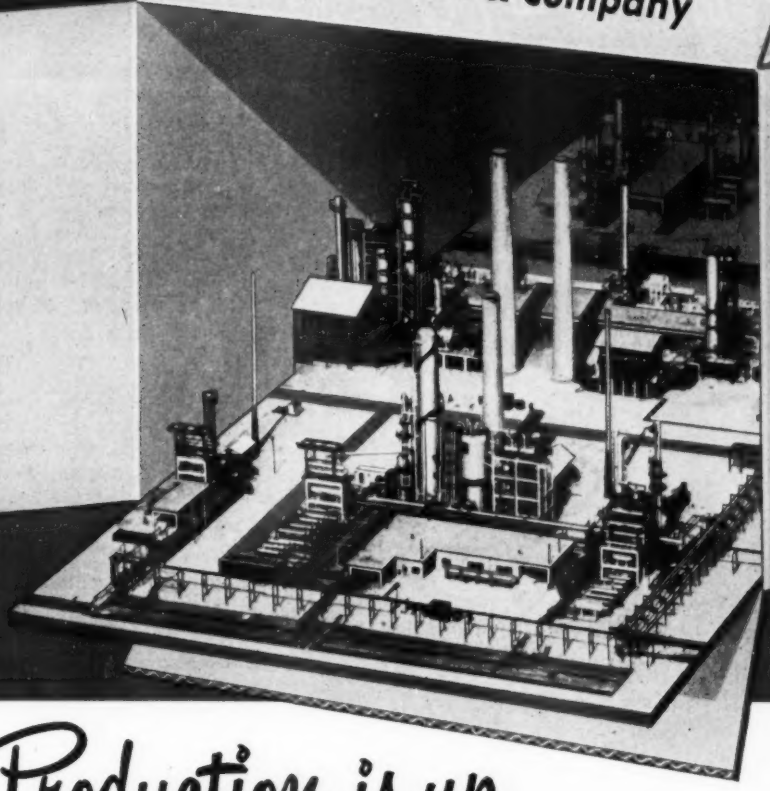
Independent *Geophysical Surveys*

EXPLORATION COMPANY

1973 WEST GRAY ★ HOUSTON, TEXAS

ESTABLISHED 1932

20,000 BARREL REFINERY
Engineered by
Arthur G. McKee & Company



Production is up

ON NEW "TOOLS" FOR PETROLEUM REFINING

McKEE is engineering and constructing complete refineries, individual processing units and other refining facilities in many locations. The Refinery Division of this organization will continue to devote every effort toward keeping pace with the Refining Industry's expansion program.

McKee Engineering

DESIGN, ENGINEERING AND CONSTRUCTION FOR THE PETROLEUM REFINING AND IRON AND STEEL INDUSTRIES

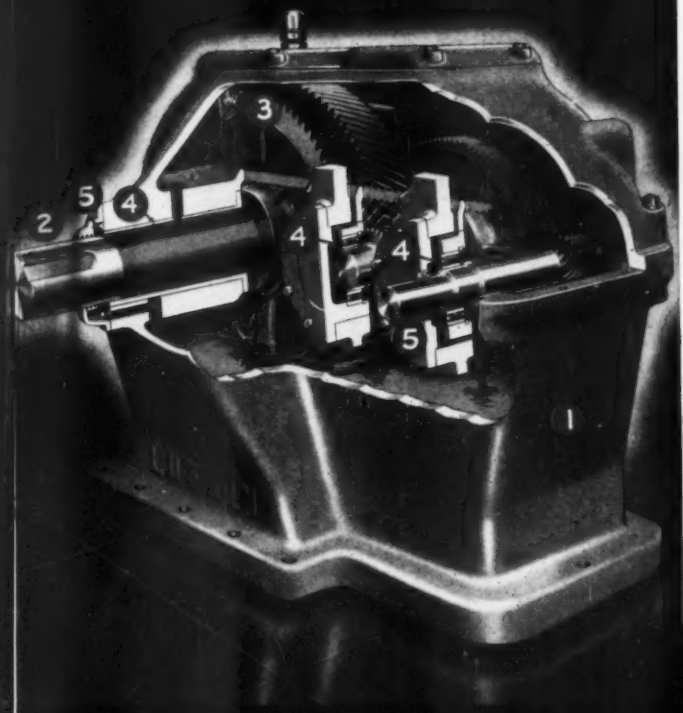
Arthur G. McKee & Company • Established 1905

Headquarters: McKee Building, 2300 Chester Avenue, Cleveland 1, Ohio. *New York:* 30 Rockefeller Plaza, New York 20, N.Y. *Tulsa:* 918 First National Bank Building, Tulsa 3, Okla. *England:* The Iron and Steel Division of Arthur G. McKee & Company, is represented by Head, Wrightson & Co., Ltd.

The Lufkin

Gear Box Lubrication System . . .

The heart of an oil field pumping unit is the gear reducer. Pumping service is generally considered to be one of the toughest applications for gears. Lufkin's total output of gear reducers in this class is now over thirty thousand units. Here are the reasons Lufkin is still first in oil field reducers:



1. The Lufkin reducer housings are of rugged construction and especially built for oil well service.

2. All shafts are forged from alloy steel which is heat treated and precision ground.

3. Gears which are precision cut on our Sykes Herringbone machines are used exclusively in Lufkin Units. These gears operate in an oil bath with gear wipers to flood the bearings.

4. Lufkin uses oversize bronzoid bearings on crankshafts and the crankshaft is held rigid by hub plates on the bearing. The pinions float on Hyatt Hy-Load Roller Bearings.

5. The pinion shaft bearings are equipped with patented oil seals, to prevent oil leaks; while the main crankshaft is equipped with collar oil slingers and annular grooved drain covers.

LUFKIN FOUNDRY & MACHINE COMPANY

LUFKIN, TEXAS

Branch sales and service Houston, Dallas, New York, Tulsa, Los Angeles, Seminole, Oklahoma City, Corpus Christi, Odessa, Kilgore, Wichita Falls, Casper, Wyoming, Great Bend, Kansas.

Lufkin Equipment in CANADA is handled by

THE LUFKIN MACHINE CO., LTD. 14321 108th Avenue, Edmonton, Alberta, Canada.

LUFKIN PUMPING UNITS

LUFKIN-COOPER-BESSEMER ENGINES

LUFKIN OIL FIELD AND INDUSTRIAL TRUCK TRAILERS

INDUSTRIAL SPEED REDUCERS AND INCREASERS

DIVISION LUFKIN FOUNDRY & MACHINE COMPANY INDUSTRIAL, MILL AND AUTOMOTIVE SUPPLIES

"PERFORMANCE sold us on American Tiger Brand Wire Lines,"

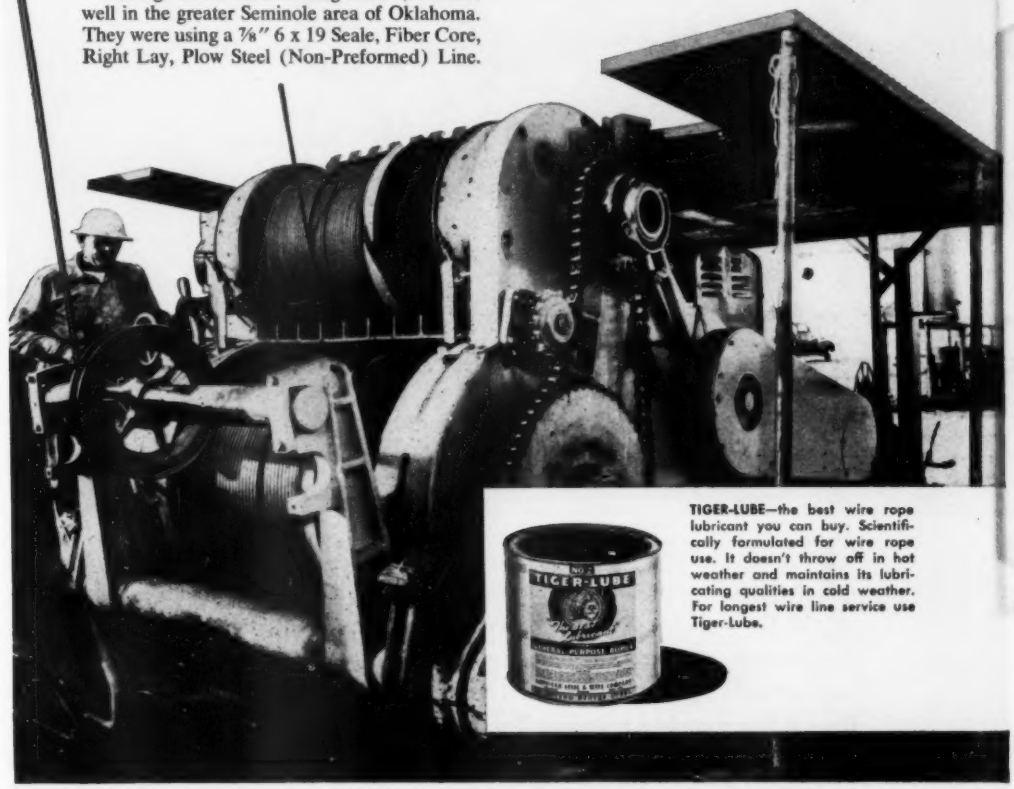
says K. D. COLE *of G. A. Manahan & K. D. Cole Rotary Drilling and Cable Tool Well Service*

● There's nothing beats day-by-day good performance. That's why Manahan and Cole of Tulsa, Oklahoma, use American Tiger Brand for all of their well-servicing rigs.

K. D. Cole says, "Performance of American Tiger Brand Wire Rope has sold us this rope for both rotary drilling lines and sand lines. American is the *top* wire line with us."

The rig shown was swabbing out a 4,000-foot well in the greater Seminole area of Oklahoma. They were using a ⅞" 6 x 19 Seale, Fiber Core, Right Lay, Plow Steel (Non-Preformed) Line. The sand line was ⅝" 6 x 7, Fiber Core, Right Lay, Plow Steel.

Wire lines used on well-servicing rigs take a severe beating and it pays to use the ones that have proved themselves in the field. There are none better than American Tiger Brand and now that steel is getting scarce, switch to Tiger Brand for longest service.



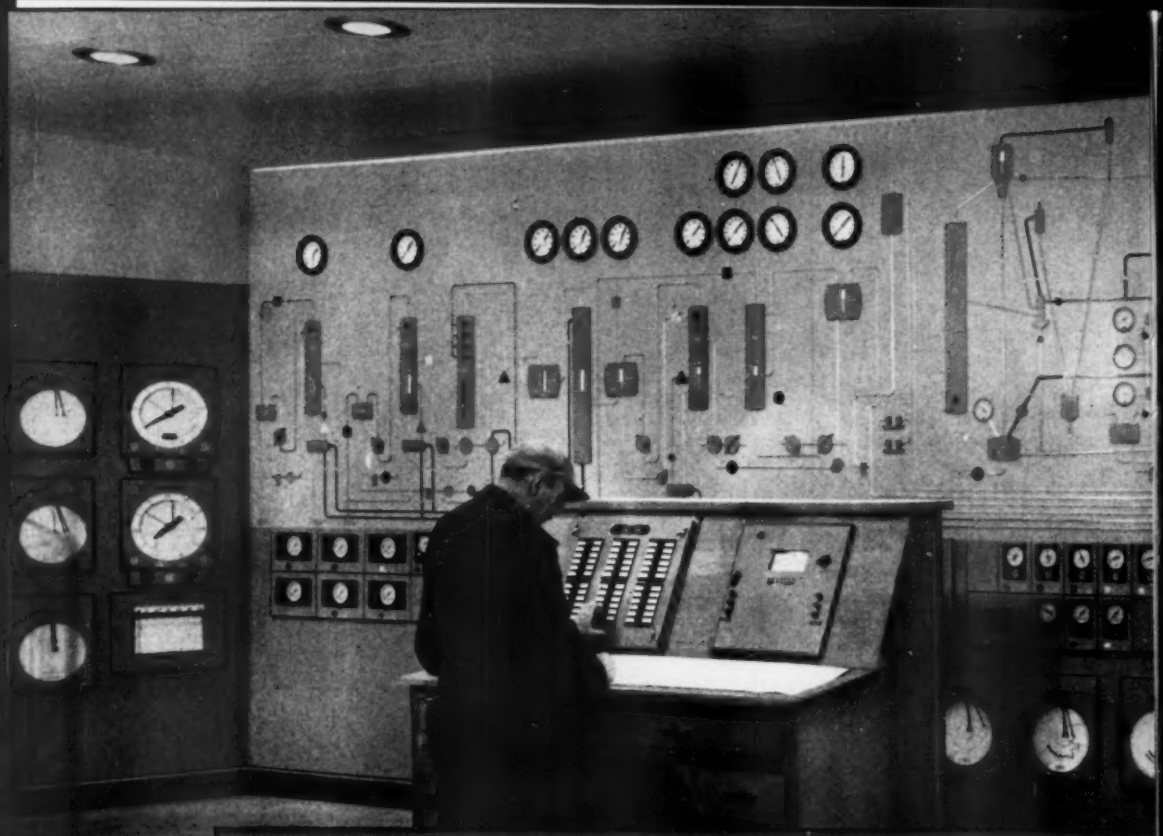
TIGER-LUBE—the best wire rope lubricant you can buy. Scientifically formulated for wire rope use. It doesn't throw off in hot weather and maintains its lubricating qualities in cold weather. For longest wire line service use Tiger-Lube.

AMERICAN STEEL & WIRE COMPANY, GENERAL OFFICES: CLEVELAND, OHIO
COLUMBIA STEEL COMPANY, SAN FRANCISCO • UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

AMERICAN TIGER BRAND WIRE ROPE

UNITED STATES STEEL

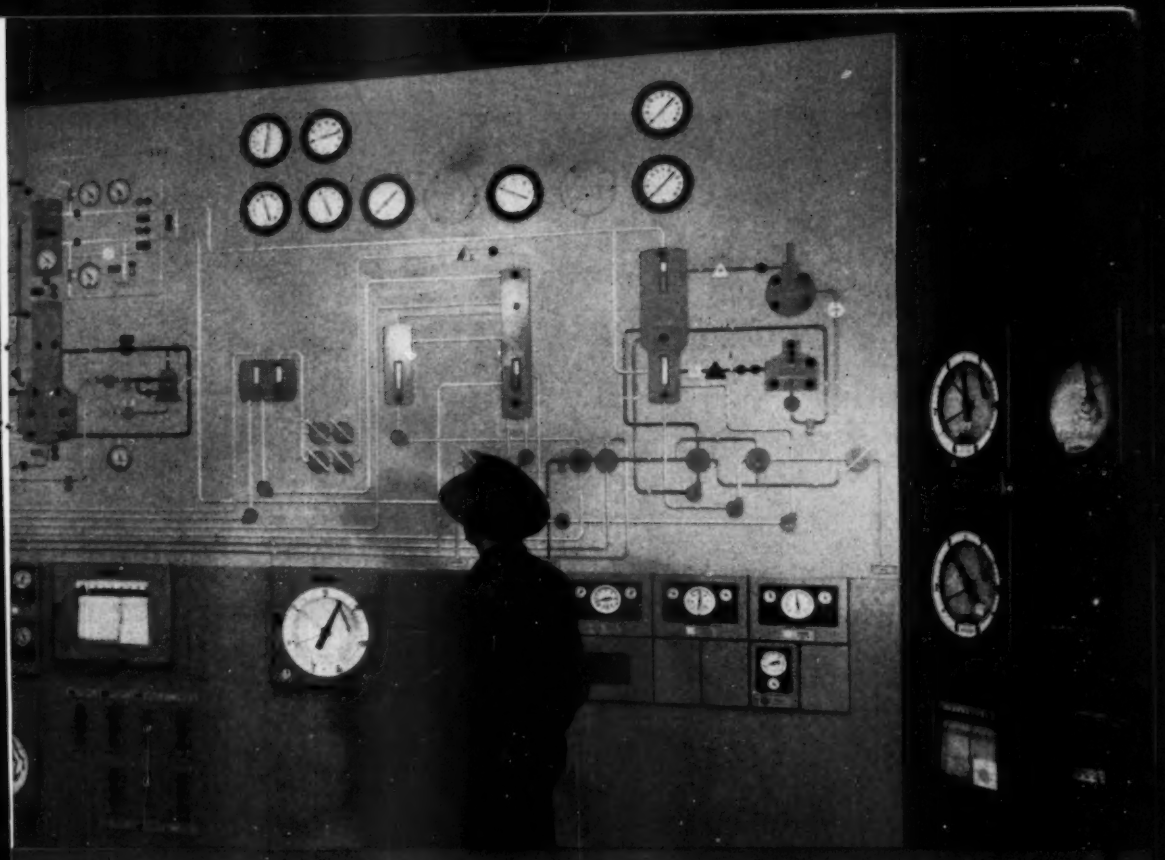


This *ColorGrafic* panel

THIS new Brown *Color Grafic* Panel at the Great Lakes Refinery of Petco Corporation dramatically illustrates, in panoramic style, all symbols and flow lines of four complete processes. The details of Houdriflow*, polymerization, gas recovery and feed preparation are easily followed and controlled. Twelve different colors are used to indicate such flows as high pressure condensate, reactor charge and gasoline, product gas, air, catalyst, and others.

This consolidated control of the four processes lowers operating expenses . . . increases operator convenience . . . and reduces training time for personnel, even when the trainee has little or no previous knowledge of the process being controlled.

*Constructed by Catalytic Construction Company, Philadelphia, Pa.



spotlights multi-process control

Such instrumentation permits the separation of recording and controlling functions—thereby, affords the opportunity to utilize improved mechanisms like the Brown mercuryless Differential Converter. Space is saved through smaller control areas. Installation is easy . . . start-up is simplified.

Vol. 5 No. 3 of INSTRUMENTATION contains a detailed description of this installation. Write for a copy . . . and for folder No. 228-1 on *ColorGrafic* Panels.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4488 Wayne Ave., Philadelphia 44, Pa.

MINNEAPOLIS
Honeywell
Brown Instruments

Year after year

CONSISTENTLY
the best weight material

500 DISTRIBUTION POINTS PUT BAROID WHERE YOU WANT IT WHEN YOU WANT IT

AND THERE ARE GOOD REASONS WHY!

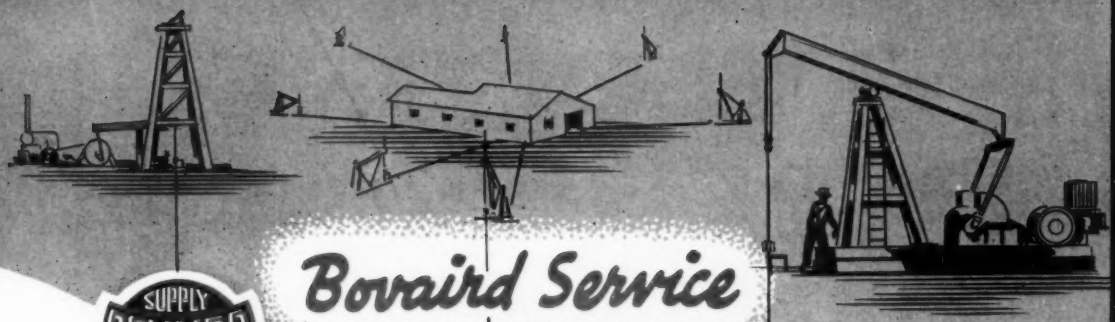
Ever since 1925, when Baroid was first introduced, operators and drillers have found Baroid uniformly, *consistently*, tops in quality. The pure ground barytes in *every* sack in *every* batch meets the same high standards of fine grind, high specific gravity and freedom from impurities. Baroid consistently provides maximum weight with minimum viscosity.

HOW? BECAUSE...

Baroid Sales Division owns and operates the most extensive deposits of high-grade barytes, and the milling processes are supervised by trained metallurgists whose assignment is to make *every* sack of Baroid meet the highest standards of quality.

Baroid
BAROID SALES DIVISION
NATIONAL LEAD CO.
Los Angeles 12 . Tulsa 3 . Houston 2

COMPLETE DRILLING MUD SERVICE



Bovaird Service HAS MATCHED THE PACE OF PRODUCTION

SUPPLY BOVAIRD COMPANY

1871
200 FT.

SUPPLY BOVAIRD COMPANY

1901
2,000 FT.

PETROLEUM EQUIPMENT SUPPLIERS ASSOCIATION MEMBER

During 80 years of service to the oil industry, Bovaird has seen many changes in drilling, producing, refining, and pipeline equipment and methods of operation.

That's why Bovaird maintains an experienced, well-informed sales staff, ever alert to changes in equipment to meet present operating needs.

From the early-day walking beam to the modern pumping unit, Bovaird has always stocked the newest equipment and supplies for every oil field operation. And Bovaird's 22 strategically located offices and stores assure the oil industry of a complete, dependable service and an adequate source of supply.

SUPPLY BOVAIRD COMPANY

OFFICES AND STORES

ILLINOIS—Clay City, Grayville, Salem
KANSAS—Chase, Great Bend, McPherson
Pratt, Russell, Wichita
OKLAHOMA—Duncan, Oklahoma City,
Pauls Valley, Ringwood, Sapulpa,
Seminole, Tulsa
TEXAS—Borger, Dallas, Midland, Odessa,
Pampa, Snyder

1951
20,000 FT.

"Buy From Bovaird"

THE Bovaird SUPPLY COMPANY

GENERAL OFFICES
TULSA, OKLAHOMA

80 YEARS OF PROGRESS WITH THE OIL INDUSTRY

Why the FIRST names in pipelines depend on the FIRST* name in line pipe

*FIRSTS by A. O. SMITH • Welded line pipe • Internal expanded pipe • Light wall large diameter pipe • World's largest producer of large diameter welded steel line pipe

"Straight as a die" can be taken literally when oil men discuss A. O. Smith Line Pipe. That's because A.O. Smith's internal expanding process stresses the pipe beyond its yield point—and when pipe is stressed beyond its yield point by uniform internal expansion it automatically comes out round, straight, and consistently of the right diameter.

Uniformly round, straight pipe eliminates time-consuming "line-up" operations in the field and makes possible consistent "stringer bead" welds.

In addition, the A. O. Smith expanding process produces pipe of high yield strength permitting higher operating pressures without the use of alloy steels and their accompanying special welding practices. No wonder the *first* names in pipelines depend on the *first* name in line pipe!

A. O. Smith Line Pipe is available in a complete range of sizes and wall thicknesses, from 8⅝ in. to 36 in. in diameter.

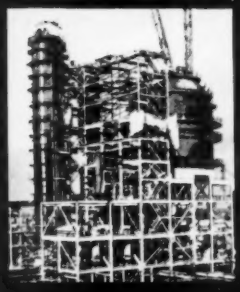
77th ANNIVERSARY

A.O.Smith

LINE PIPE • CASING

Atlanta 3 • Chicago 4 • Dallas 2 • Denver 2 • Houston 2
Los Angeles 14 • New York 17 • Pittsburgh 19 • Salt Lake City 1 • San Francisco 4 • Seattle 1
Tulsa 3 • Washington 6, D.C. • International Division: P.O. Box 2023, Milwaukee 1

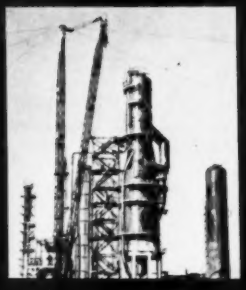
DEPENDABILITY through RESEARCH and ENGINEERING



fluid catalytic cracking

In building — as in operating — economy demands flexibility of many engineering functions. Flexibility — in both cracking and engineering — is a product of a comprehensive "know-how" . . . and "know-how" is the product of experience.

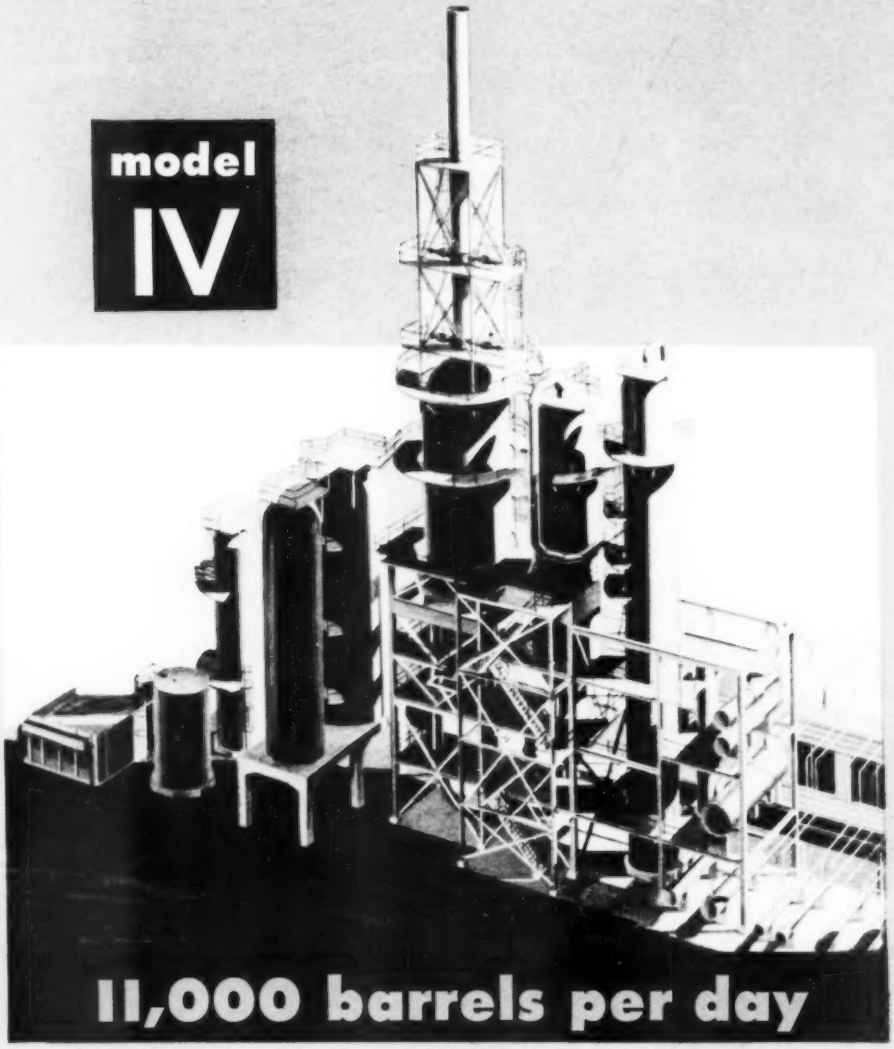
Foster Wheeler has designed and constructed Fluid Catalytic Cracking Units since 1941 and is now building 9 "fluid" units in different parts of the world. This experience, available to refiners — anywhere in the world — is the basic component of Foster Wheeler's complete engineering and construction service.



FOSTER WHEELER CORPORATION

165 BROADWAY, NEW YORK 6, NEW YORK

model IV



11,000 barrels per day

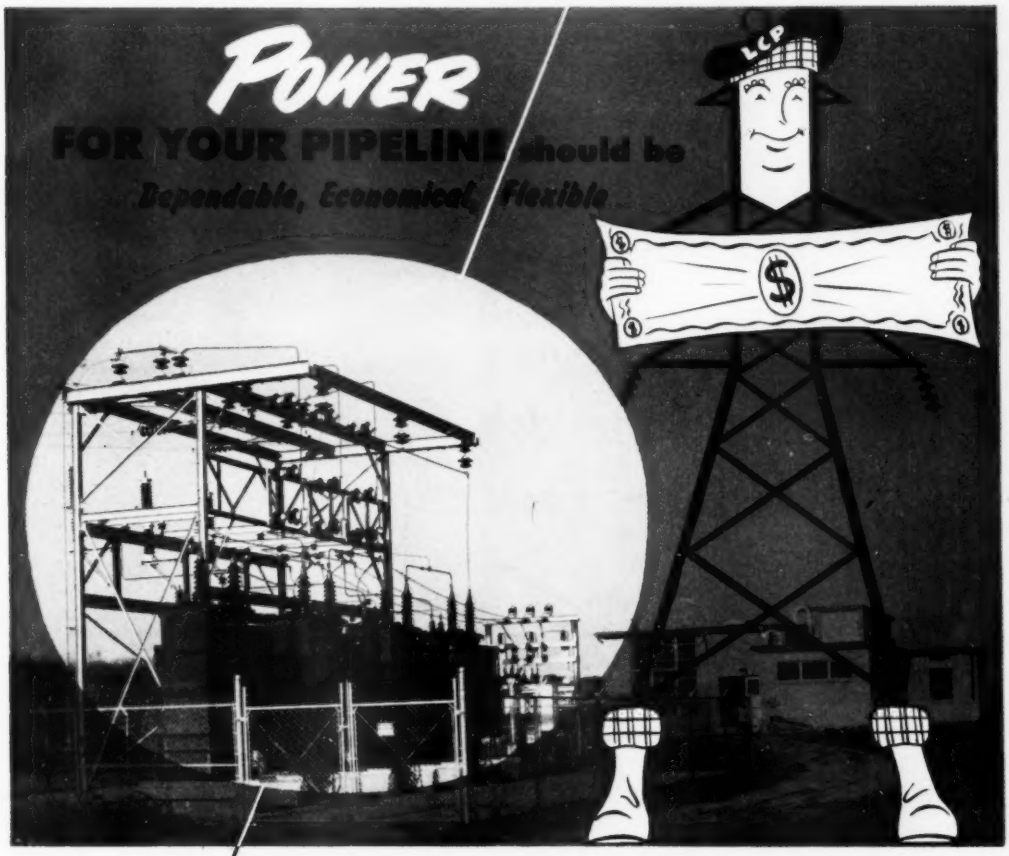
More barrels of high octane product per ton of steel used **is a factual statement which most adequately sums-up the many design improvements built into this new Fluid Catalytic Cracking Unit.**

The artist's drawing of the 11,000 bbl/day Model IV unit now being built by Foster Wheeler for Imperial Oil Limited, at Edmonton, Canada, highlights the compactness of this truly new "fluid" design. Two more Model IV units are being designed and constructed by Foster Wheeler.

For further information, address your inquiries to:

FOSTER WHEELER CORPORATION

165 BROADWAY, NEW YORK 6, NEW YORK



LCP S-T-R-E-T-C-H-E-S Your Power Dollar

LOW COST POWER handles the biggest jobs with trouble-free efficiency. If the job is only a fractional horsepower motor, Utility Electric LOW COST POWER is your best bet, too. . . . You get all the advantages of low operating, maintenance and labor costs . . . easy portability . . . fast starting in all weather . . . s-l-o-w depreciation. Save on initial cost of power-driven equipment. Save on repairs. *Everything's up* EXCEPT *Utility Electric Power.*

USE *Utility* ELECTRIC POWER

PETROLEUM ELECTRIC POWER ASSOCIATION

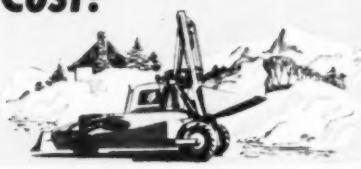
WHEREVER ENGINES WORK

In Construction, Chrysler Powers
Ditching Machines • Cranes • Truck Mixers • Shovels • Loaders • Yarders • Concrete Mixers • Road Pavers • Crane Carriers • Scoop Tractors

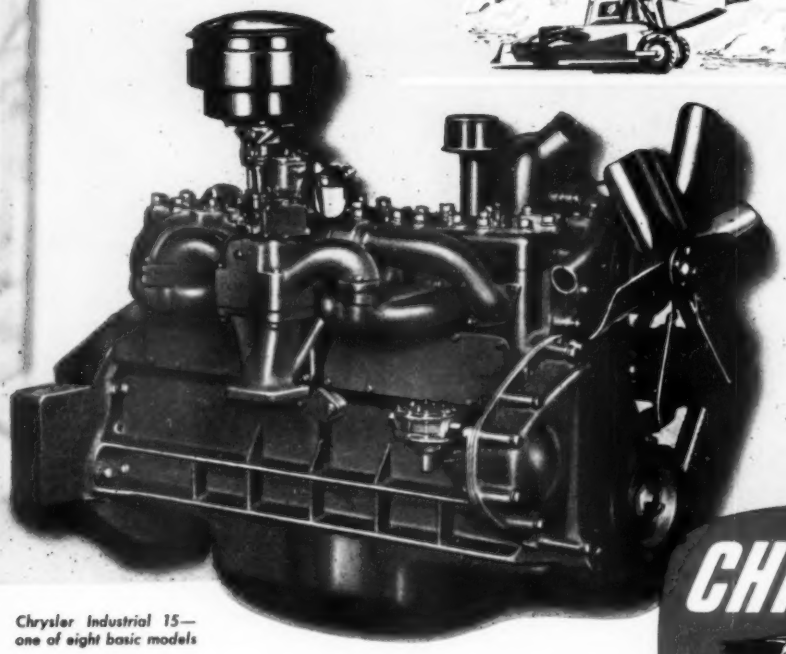
In Industry, Chrysler Powers
Air Compressors • Hoists • Derricks • Pumps • Generators • Tractors • Arc Welders • Baling Machines • Conveyors • Tackle Blocks • Winches

Chrysler Industrial Engines Do a Better Job at Lower Cost!

In Farming, Chrysler Powers
Tractors • Combines • Gang Mowers • Spreaders • Irrigation Equipment • Orchard Sprayers • Hay Choppers • Pumps • Feed Mills • Sprinklers



In Other Fields, Chrysler Powers
Locomotives • Motor Coaches • Air Conditioning Equipment • Pulp Machines • Drilling Equipment • Fire Pumps • Snow Plows • Street Flushers • Saw Mill Equipment • Oil Well Pumps and Drillers



Chrysler Industrial 15—one of eight basic models

More manufacturers, more operators of industrial equipment are discovering the brilliant efficiency of Chrysler Industrial Engines on scores of different applications.

For Chrysler Industrial Engines are built *solely for industrial jobs.* Furthermore, Chrysler Industrial Engines are designed and engineered to meet the *specific working requirements* of each type of equipment they power. They can also be adapted to special regional operating conditions.

A letter of inquiry will bring an engineer well qualified to discuss your particular application. Address: *Industrial Engine Division, Chrysler Corporation, Detroit 31, Michigan.*

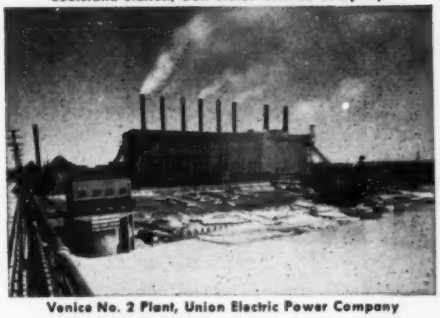
CHRYSLER

HORSEPOWER WITH A PEDIGREE

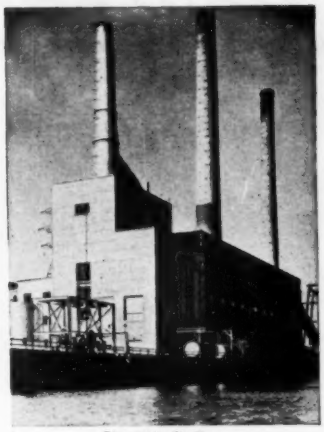
Hookers Point Station, Tampa Electric Company

Possum Point Station, Virginia Electric & Power Co.

Louisiana Station, Gulf States Utilities Company



Venice No. 2 Plant, Union Electric Power Company



Riverside Station,
Savannah Electric & Power Company

Designed & Constructed
by
Stone & Webster
Engineering Corporation
and using

OIC Valves are *precision engineered* and *precision built*. OIC engineers offer you *precision application* help.

THE OHIO INJECTOR COMPANY
WADSWORTH, OHIO

OIC
FOUNDED 1883

VALVES

FORGED AND CAST STEEL · IRON · BRONZE

How can you benefit

from these 34 major pipelines?

How? By applying to your future operations the electrical features developed for these 34 major oil and gas lines. Westinghouse is the source for this information.

Centralized automatic control

For example, in one new Westinghouse-equipped pumping station, centralized automatic control has been applied. The mere pressing of three buttons by a single employee, performs twelve operations in six minutes, that would normally take two or three men an hour. The savings in manpower and increase in revenue through fast starting are tremendous. And there's no chance of damage through opening valves in the wrong order.

Highly flexible and reliable operation

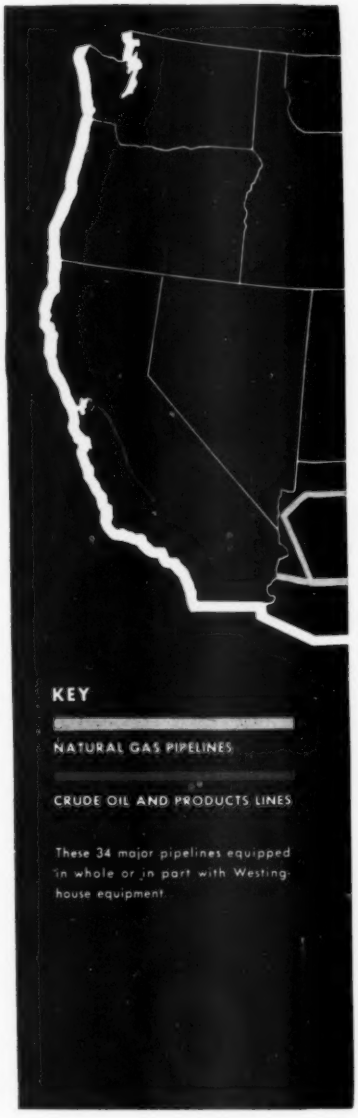
Electrical control has been developed that makes it easier to maintain operating schedules. With such control, all pumping stations can be more easily operated in step. This eliminates the need for storing successive pumpings in balance tanks with the resultant interbatch contamination.

Advancements in Power Systems

Westinghouse has made major advancements in Power Systems for pumping stations. All high-voltage equipment can be enclosed in metal-clad switchgear. This saves installation dollars, makes maintenance more convenient, and provides the ultimate in safety to personnel. The low-voltage circuit breakers and motor controls are centralized in compact Control Centers.

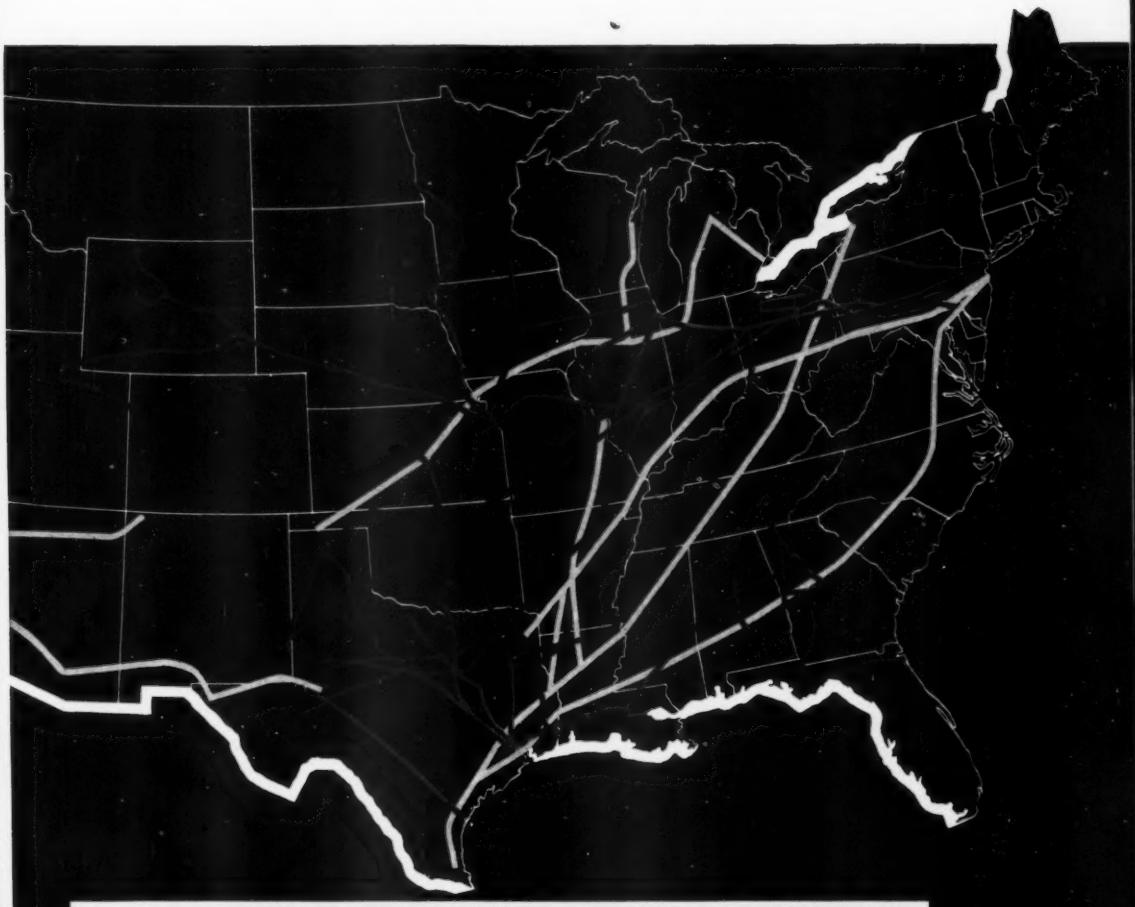
Call Westinghouse early when you plan

The experience gained in equipping these 34 lines is invaluable. Interest in remotely operated and automatic pumping stations is increasing and it's interesting to note that 20 years ago Westinghouse equipped the first pipeline pumping station for remote supervisory control. And Westinghouse Engineers are continually working on new developments to minimize the cost of pump station attendance. When your next job comes up, call Westinghouse early in the planning stage. Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Penna. J-94883


KEY
NATURAL GAS PIPELINES
CRUDE OIL AND PRODUCTS LINES
These 34 major pipelines equipped in whole or in part with Westinghouse equipment.

YOU CAN BE SURE... IF IT'S Westinghouse

EQUIPMENT FOR THE PETROLEUM INDUSTRY



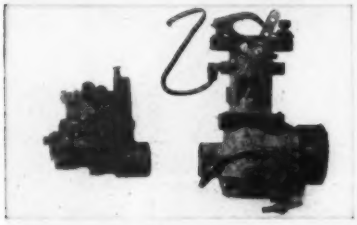
A group of 1,250-horsepower forced-ventilation motors installed in a pumping station of a large crude oil pipeline. All units, including the suction and discharge valves and the ventilation blowers, are remotely operated by a sequence control system.

Pressing buttons on this control desk starts the main pumps and operates valves. Indicating lights show valve position. Other lights identify the operation of protective devices which warn of abnormal conditions. Buttons at right control booster pumps.

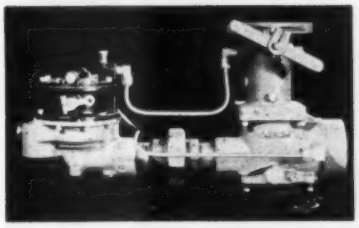
How to make 'em Last Longer

Ensign parts available for all Early Models of Gas Carburetors and Regulators

Before



After



In keeping with the CONSERVATION order of the day, here's how you can stretch out the useful life of your carburetor equipment.

1. Keep air cleaner to carburetor connections tight. A dust leak wears out carburetor shafts, bushings, and engines.
2. Check engines for loose mounting bolts. Vibration causes excessive wear on all parts and accessories.
3. Replace any worn carburetor and regulator parts; diaphragms, shafts, valves, seats, gaskets, etc.
4. Request ENSIGN Service Bulletins covering the ENSIGN equipment on your engine.

ENSIGN Carburetors are built to out-last the engines on which they are installed. A reasonable amount of preventative maintenance will help both carburetor and engine to render long uninterrupted service.

ENSIGN

CARBURETOR COMPANY

When requesting ENSIGN Service Bulletins, please specify make and model of engine on which carburetor is installed. Also, fuels used.

7010 South Alameda St., Huntington Park, Calif. • 2330 West 58th St., Chicago 36, Illinois

HARD HAT FACTS

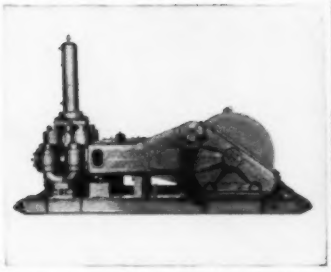
to help you choose field-proved oil field equipment

Gardner-Denver field engineers have their own hard hats—wear them often as they visit oil fields throughout the world. They know from first-hand field experience just what your most troublesome problems are — just what you expect oil field equipment to do.

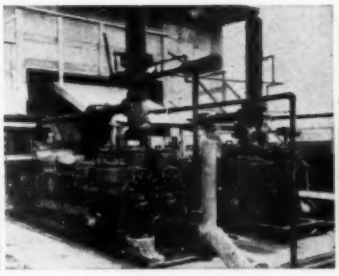
That's one reason Gardner-Denver equipment meets your needs so well. There's no guessing about its performance in the field or on your rig.

There's GarDurloy, for example. That's the tougher alloy iron specially developed by Gardner-Denver metallurgists for oil field service. It's used extensively in all the Gardner-Denver pumps shown here —gives them extra strength—extra resistance to shock loads and continuous heavy duty service.

Write for complete information.

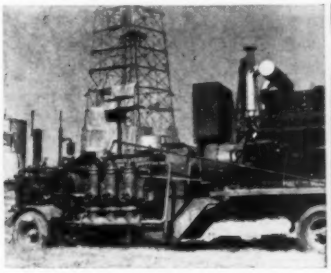


Gardner-Denver 7½ x 18 GXR Power Slush Pump

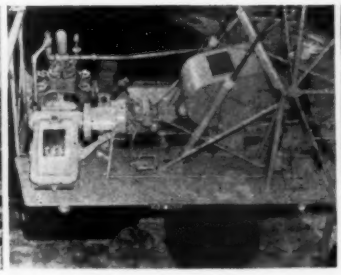


Gardner-Denver 7¼ x 16 FX Power Slush Pump

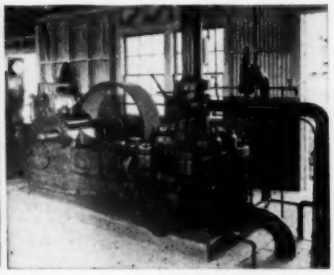
Gardner-Denver 16¼ x 8 x 20 Steam Slush Pump



Gardner-Denver PL7 Cementing Pump



Gardner-Denver 4½ x 6 FX Power Pump on Seismograph Rig



Gardner-Denver 7¼ x 10 FX Oil Line Pump

SINCE 1859

GARDNER-DENVER

Gardner-Denver Company, Quincy, Illinois

In Canada: Gardner-Denver Company (Canada), Ltd., Toronto, Ontario

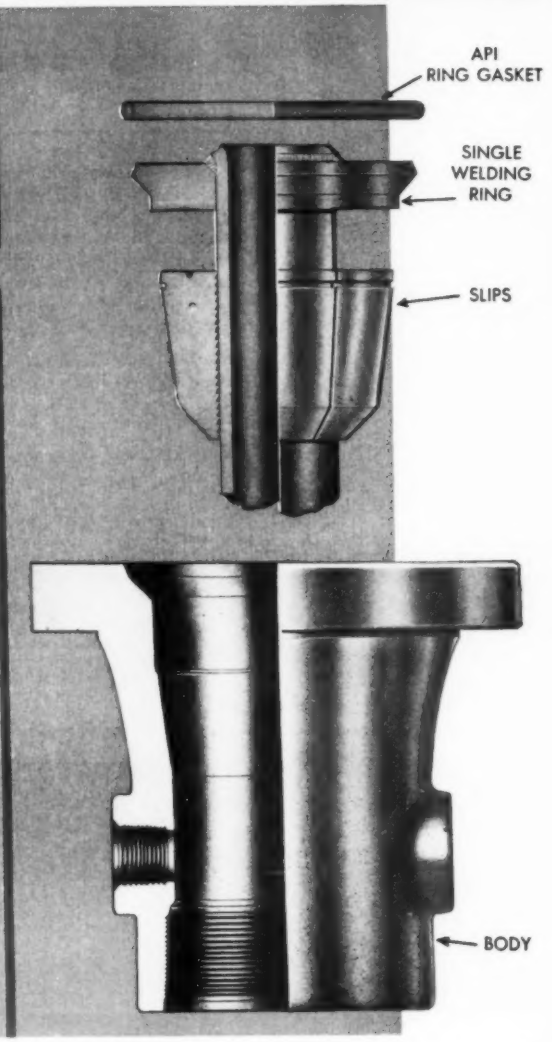
Dallas • Houston • Tulsa • St. Louis • Los Angeles • San Francisco • New York
Chicago • Pittsburgh • Denver • New Orleans
Continental Supply Co., Continental Bldg., Dallas, Texas
Export Division: 30 Rockefeller Plaza, New York, N. Y.
Republic Supply Co. (Of Calif.), 2600 S. Eastland Ave., Los Angeles, Calif.

THE QUALITY LEADER IN COMPRESSORS, PUMPS AND ROCK DRILLS

SAFEST of ALL.... SIMPLEST to Install!

RECTORHEAD CASING HEADS

- **NO** resilient seals
- **NO** packing replacement costs
- **NO** bulky welding flanges
- **NO** complex packing arrangement
- **NO** leaks due to freezing



GOOD WELD PLUS API RING GASKET

This exclusive Rector sealing arrangement puts a "Ring of Steel" between casing string and head body. Floating welding ring is welded to any grade of pipe by your welders. API ring gasket, seating in groove at junction of welding ring and head body, completes the seal when subsequent equipment is flanged in place.

LEAK-PROOF FOR LIFE OF WELL

The "Ring of Steel" is a positive, permanent leak-proof seal. It is immune to corrosion inhibitors . . . not subject to contraction . . . cannot burn out . . . will not deteriorate . . . never requires replacement.

YOU'RE MONEY AHEAD WITH RECTORHEAD

Specify Rectorheads for money-saving ease and speed of installation . . . for freedom from repacking and maintenance costs . . . for trouble-free, leakproof protection for the life of your wells. Ask your Rector Representative, authorized supply store, or write for catalog.

ALL blowout preventers, valves, flanges, spools and tubing heads of API specifications will bolt to all RECTORHEADS.

RECTOR WELL EQUIPMENT COMPANY INC

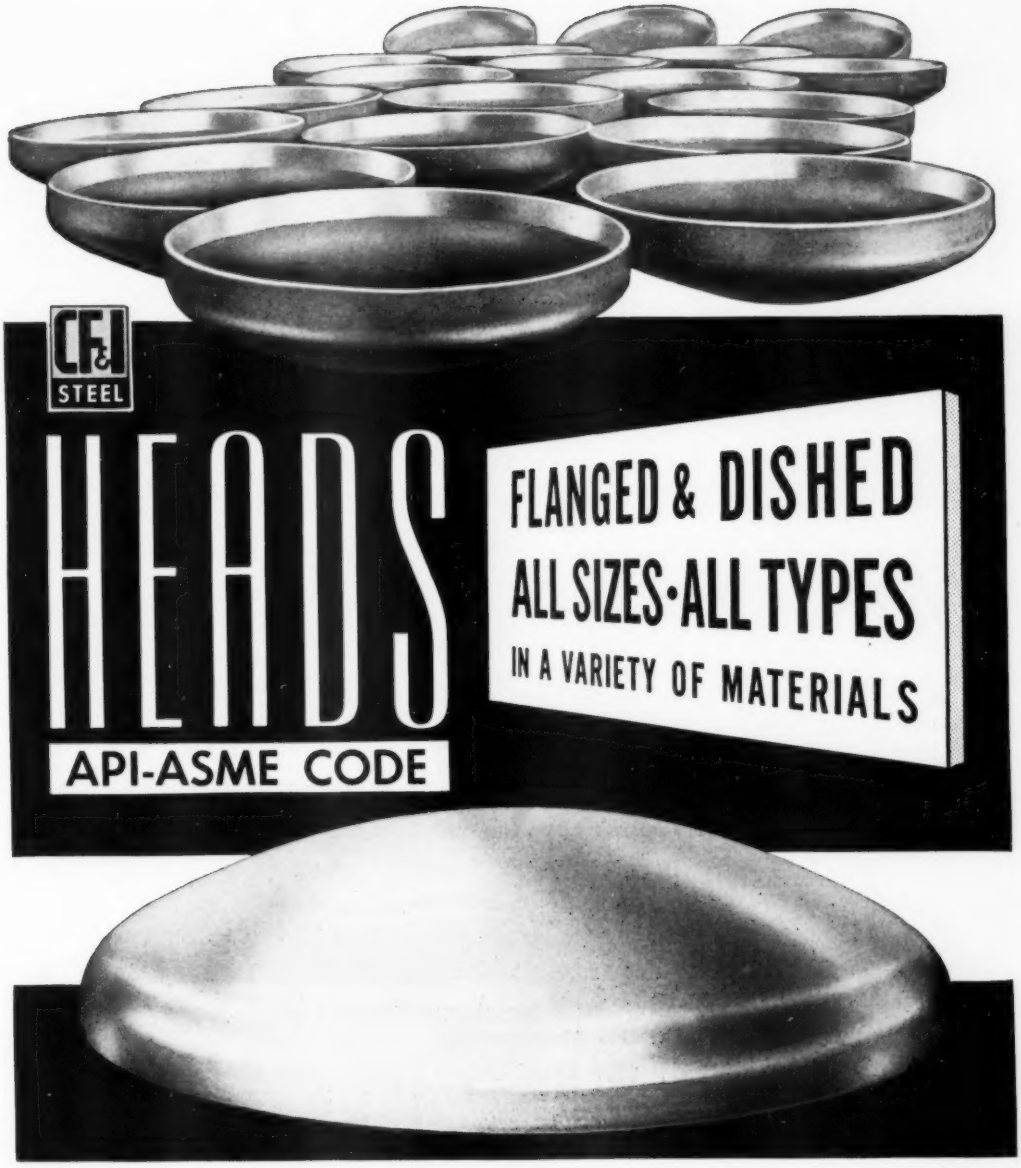
★ MAKING THE OIL INDUSTRY SAFER ★

1100 NORTH COMMERCE ST. FORT WORTH, TEXAS

Houston Plant: 2215 Commerce St.

REPRESENTATIVES IN ALL ACTIVE FIELDS

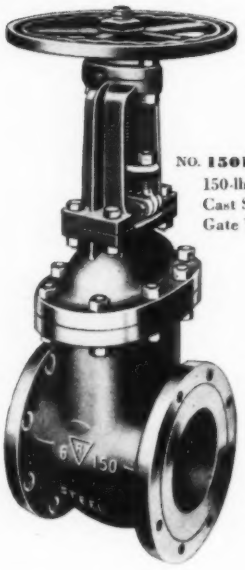
RECTORHEAD RECTOR FULL BORE CEMENTING METHOD RECTORSEAL



FLANGED AND DISHED HEADS · CARBON AND STAINLESS-CLAD STEEL PLATES
LARGE DIAMETER WELDED STEEL PIPE

CLAYMONT STEEL CORPORATION · Claymont, Delaware
a subsidiary of CF&I—THE COLORADO FUEL & IRON CORPORATION

R·P&C VALVES



NO. **1501**
150-lb.
Cast Steel
Gate Valve

Throughout the Oil Industry—
the *Quality* Valves are *R-P&C*

- R-P&C Cast Steel Valves are on the job throughout the oil industry helping to maintain uninterrupted production with their long and trouble-free service.
- Your R-P&C distributor has them—or can get them for you. Your nearest R-P&C district office will gladly furnish details about the line.

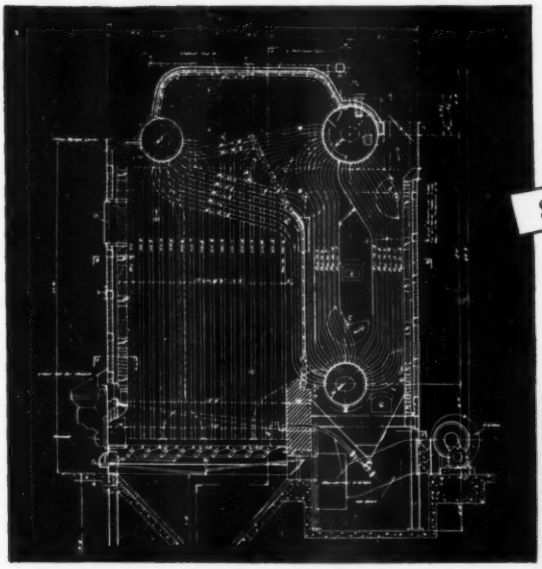
ACCO

Reading, Pa., Atlanta, Baltimore, Boston, Chicago, Denver, Detroit, Houston, New York, Philadelphia, Pittsburgh, San Francisco, Bridgeport, Conn.

R-P & C VALVE DIVISION
AMERICAN CHAIN & CABLE

"Intentionally Better"
READING-PRATT & CADY VALVES

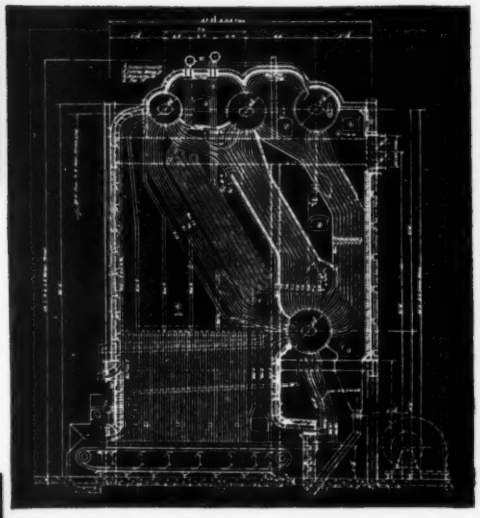
Quick Steaming at all Ratings!



Carry high overloads with high efficiency

SPECIFY Vogt

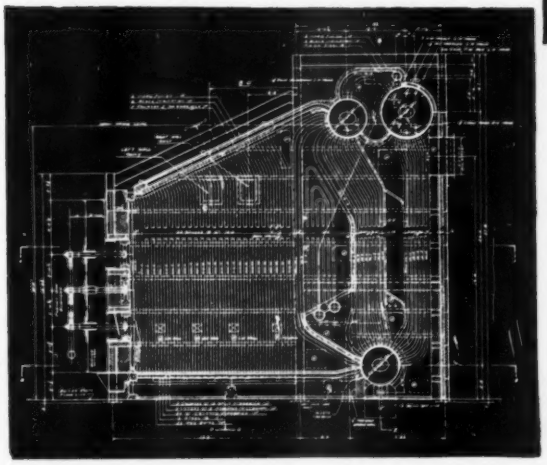
STEAM GENERATING UNITS



CLASS VL Two 27,500 pounds per hour units, installed at Brown-Forman Distillers Corporation, Louisville, Ky. Features large furnace volume in limited space, with high ratio of radiant heating surface.

CLASS LE Mt. Carmel Public Utility, Mt. Carmel, Illinois, is served by this 60,000 pounds per hour unit. Generous steam liberating surfaces and steam space permit wide fluctuations in load.

CLASS VR 70,000 pounds per hour steam generator at Humble Oil and Refining Company, Johnsue, Texas. An efficient, high-duty unit with water cooled furnace, using refinery gas fuel.



Vogt builds a complete line of bent tube steam generators, designed to burn solid, liquid, or gaseous fuels to meet specific operating conditions. Superheaters, air preheaters, economizers, water walls, and soot blowers can be readily incorporated. Bulletins with general information and showing typical installations are available upon request.

HENRY VOGT MACHINE CO.

LOUISVILLE 10, KENTUCKY

BRANCH OFFICES:
NEW YORK, PHILADELPHIA, CLEVELAND
CHICAGO, ST. LOUIS, DALLAS

MARSH

... the gauge with the "Recalibrator"

Any pressure gauge can be knocked out of adjustment, but when it's a Marsh Gauge you can quickly correct it with the twist of the "Recalibrator" screw.

This is not only the handiest way to correct a gauge; it is also the best way. Conventional methods of adjustment simply compensate for the error. The "Recalibrator" corrects the relationship between the movement and the bourdon tube—actually *does re-calibrate* the gauge.

MARSH INSTRUMENT CO. Affiliate of James P. Marsh Corp. Dept. L. SKOKIE, ILL.

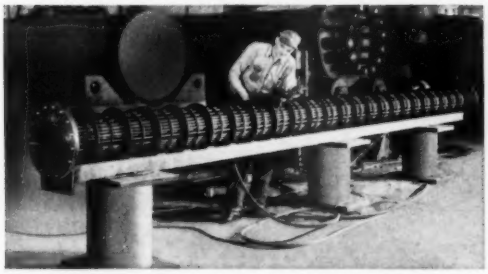
Export Dept.: 155 E. 44th St., New York 17, N. Y.

The Marsh line includes gauges especially designed for blenders, boilers, burners, capping, Christmas trees, columns, heaters, hydrogen units, instrument panels, pumps, Reid vapor bombs, scrubbers, separaters, mud pumps, stills, towers and other applications including oxygen and welding gauges. Ask on your letterhead for new catalog just off the press.

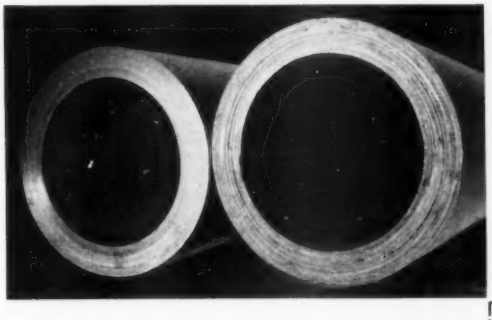
A.O.Smith Multi-Layer Heat Exchangers

MULTI-LAYER Heat Exchanger for an ammonia plant. The shell, designed for 5150 psi working pressure, is 23 inches and 13¾ inches in diameter with wall thickness of 4¾ inches and 3 inches, respectively.

Meet the Challenge of High Pressure Specifications



Heat Exchanger tube bundle for the above is designed to take advantage of low differential operating conditions within an exchanger designed for 5150 psi chemical process.



Remarkable flexibility of design and manufacture makes A. O. Smith MULTI-LAYER Heat Exchangers adaptable to a wide range of high-pressure services.

MULTI-LAYER Heat Exchanger shells are built up from concentric layers of relatively thin steel plate progressively wrapped, tightened and welded together around an inner pressure-tight cylinder.

Wrapping tension and weld shrinkage develop desirable compression in the inner layers of the shell during manufacture. This results in more equalized loading of all portions of the heat exchanger wall under working pressure. Thus, the full calculated strength of the steel is more completely utilized.

Where corrosion is a problem, only the inner shell need be made of corrosion-resistant materials. The load-bearing portion of the vessel wall—since it is not in contact with corrodents—can be manufactured of more economical and readily weldable steel plate.

This feature, alone, frequently effects substantial savings over the cost of solid alloy construction and is especially advantageous during the current restrictions on use of certain alloy materials.

Call upon A. O. Smith for assistance on your heat exchanger problems. Write the nearest office or use the handy coupon.

End view of a MULTI-LAYER Heat Exchanger shell course showing how the wall is built up from concentric layers of thin steel plate. To the right: end view after wrapping is completed. To the left: end has been machined and scarfed, ready for welding to the next shell course or end closure.

A.O.Smith

VESSELS • HEAT EXCHANGERS

77th ANNIVERSARY 1874 1951

Boston 16 • Chicago 4 • Cleveland 15 • Dallas 2 • Denver 2
Houston 2 • Los Angeles 22 • Midland 5, Texas • New Orleans
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International Division: Box 2023, Milwaukee 1

A. O. Smith Corporation
Dept. OG-751, Milwaukee 1, Wis.

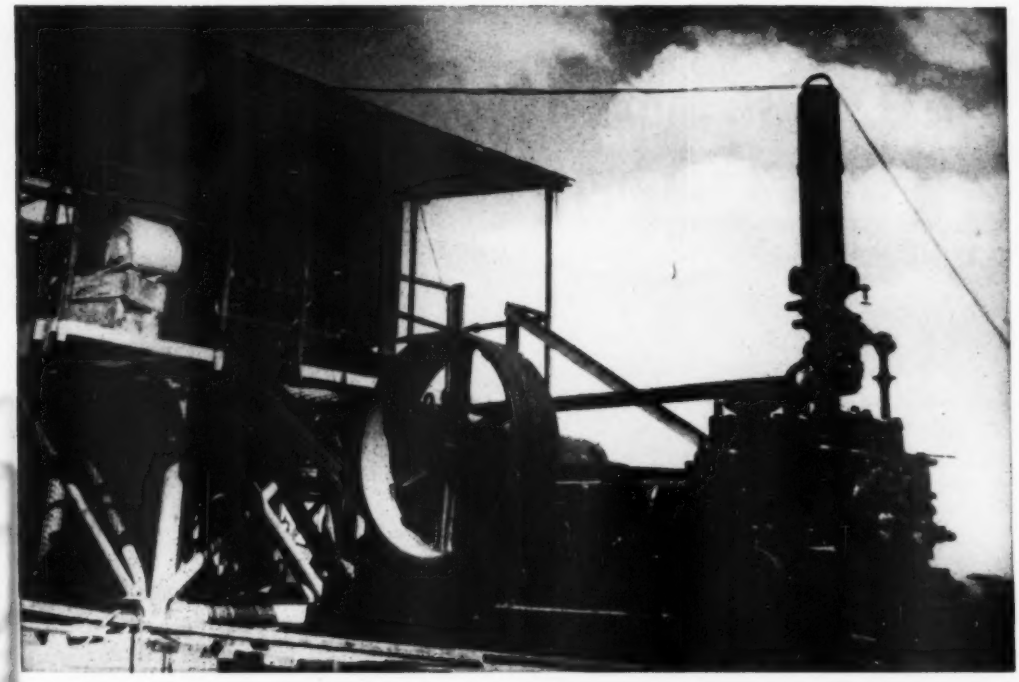
Without obligation, send me bulletins and information on your MULTI-LAYER Heat Exchangers and their construction features.

Name_____

Address_____

Firm_____

City_____



This is the Drive the Production Men Wanted ...They Got It...Now Everybody Prefers It

It was the demand of the oil production men for a sheave like this that gave the QD sheave its start.

Now it's the most widely used hub-and-rim combination . . . in *all* industries.

Why does the Worthington QD satisfy the man in the oil fields?

Because it's *stronger*. Each size is designed for the load it has to carry—rather than proportioned for various sizes from one standard design.

Because it's *easier*. Easy to *get on*—split hub is clamped to shaft, heavier taper-bored rim slides easily over tapered hub. Easy to *get off*—long pull-up bolts are used as jack screws to remove the rim; hub stays put, no realignment problem.

Because it's always *tight* on the shaft. The friction cone grip of rim on hub makes a positive press fit on the shaft.

And because it's quickly *available*. Local distributor stocks all over the Southwest and other oil field areas, are backed by factory stocks in Los Angeles, Fort Worth, Houston, Tulsa, and New Orleans.

Standardize on Worthington Multi-V-Drive, with the original tapered cone grip sheave. Worthington Pump and Machinery Corp., Multi-V-Drive Sales Division, Buffalo, N. Y.

MV.1.10

QD

*Trade Mark

Most widely used hub-and-rim sheave

WORTHINGTON

THE GOOD RIGHT HAND OF INDUSTRY

POWER TRANSMISSION: sheaves, V-belts, variable speed drives

PUMPS: centrifugal, power rotary, steam

AIR COMPRESSORS: water-cooled, air-cooled

NON-LUBRICATED VAPOR-TIGHT PLUG VALVE

KEROTEST GENERAL

TWIN SEAL

Operates in 1¼ turns
NO! NO! No Lubrication
Retracting seats can't score walls
Facings as specified
Shuts off VAPOR TIGHT
235 to 5,000 P.S.I. Working Pressures
Easy to Remove this Plate to Change Seating Slips

KEROTEST

KEROTEST MANUFACTURING COMPANY

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LOS ANGELES • CHICAGO • CHARLESTON • ODESSA • TULSA • HOUSTON • NEW YORK
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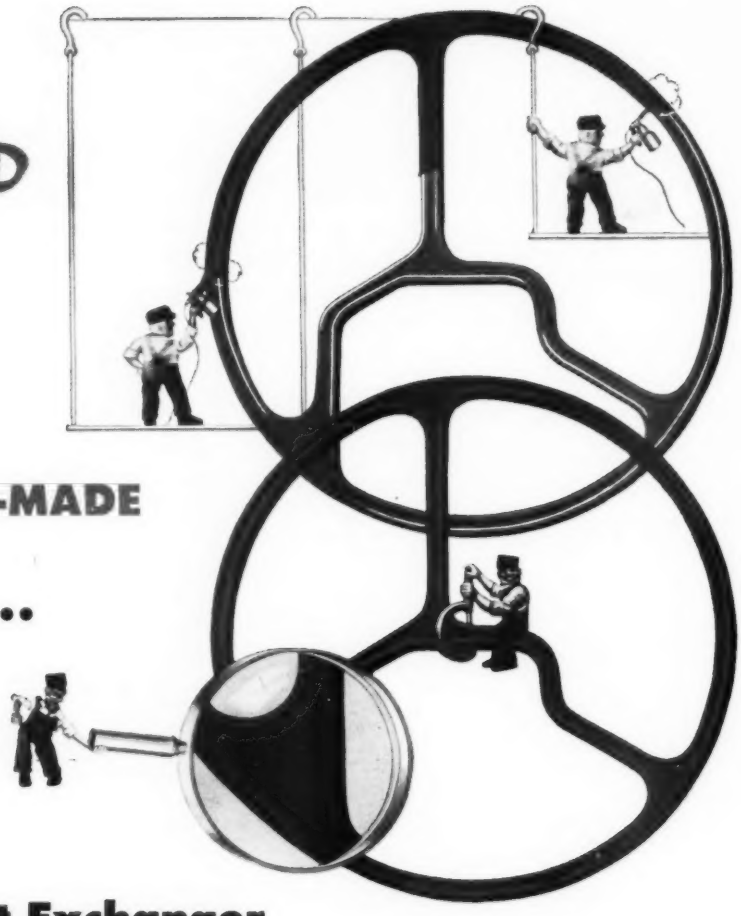
PAINTED
to resist rust...



PRECISION-MADE
to resist blowouts...

...this Heat Exchanger Gasket will stay on the job longer

The durable coating of red paint on every Goetze iron or steel-jacketed Style 923 Heat Exchanger Gasket is a sure "stop light" against rust. And rust, as every metal gasket user knows, is a primary cause of deterioration—both in the storehouse and on the job awaiting installation.

Equally important in the fabrication of Style 923 is the precision craftsmanship which eliminates cracks and wrinkles in the metal jacket—defects which can rapidly lead to leaks and blowouts.

"Custom tailoring" accounts for the meticulous care which is taken in the forming of every one of these gaskets... care which results in a long, efficient service life. You can always depend on a Goetze Style 923 to fit and seal perfectly... to stay on the job without leaks or blowouts. And that, of course, pays off in less down time and fewer gasket replacements.

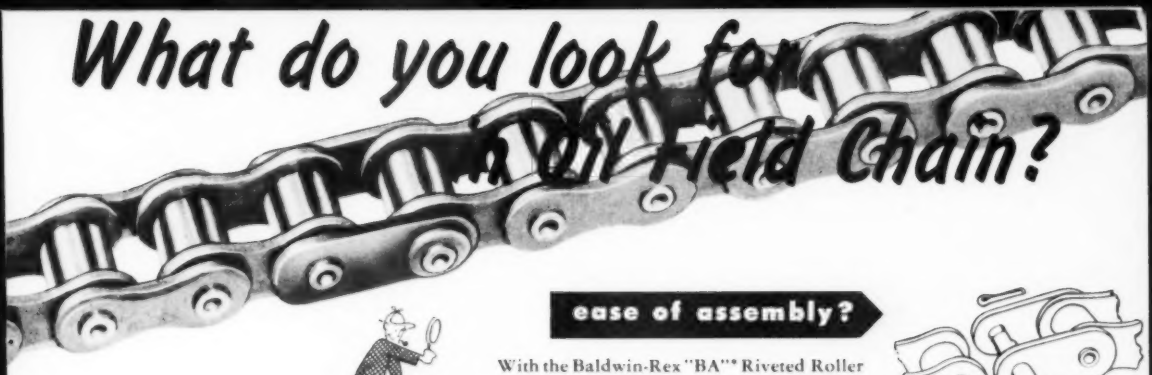
Find out how little it costs to have Goetze Heat Exchanger Gaskets "tailored" to the size and shape *you* need. For prompt estimates and recommendations, write Johns-Manville, Box 290, New York 16, N. Y.

JM

Johns-Manville *Goetze* GASKETS

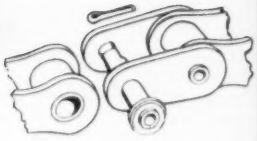
THERE'S A JOHNS-MANVILLE PACKING AND GASKET FOR EVERY SERVICE.

What do you look for in an Oil Field Chain?



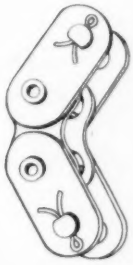
ease of assembly?

With the Baldwin-Rex "BA"* Riveted Roller Chain, assembling or disassembling roller chain in the field or in the supply store is the easiest you've ever known. Just locate the special connector link, remove the cotter and drive out the pin. That's all there is to it. No danger of damaging parts or fits as with ordinary riveted chain.



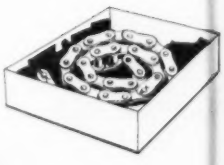
ease of adjustment and repair?

Keep a supply of "BA" 3 Pitch repair units on hand. They're your insurance against loss of drilling time. If a chain becomes damaged while in service, it can quickly be fixed right on the job by inserting one or more repair units. What's more, "BA" repair units are interchangeable with any standard roller chain.



fast, convenient service?

The "BA" Assembly is shipped in boxes containing two standard 5-foot lengths of chain. Each strand contains two single pin connectors at approximately the 2′ and 5′ mark. Thus, it's easy for you or your supply store to *build up* exact length of chain you need without "cutting" chain. Standard "BA" short units of various lengths are available for this purpose. Offset links can also be added and then removed to compensate for chain elongation.



high strength and ability to "take-it"?

All Baldwin-Rex Roller Chain is made of the finest material, manufactured to the highest quality standards. With "BA" you get all the advantages of riveted chain—long life . . . high strength . . . a more positive lock between pin and plates—plus the amazing ease and convenience of handling described above. What's more, in single strand, the cost of "BA" is actually lower than the cost of cottered chain!

*"BA" means Baldwin Assembly

So next time you order chain, be sure to "look for" the distinctive "BA" link. It's the sign of quality, convenience, service and economy.

For all the details on all Rex and Baldwin-Rex Oil Field Chains, write for bulletin 51-8. Chain Belt Company 1619 West Bruce Street, Milwaukee 4, Wisconsin

BALDWIN·REX®
ROLLER CHAINS

BALDWIN-DUCKWORTH DIVISION OF CHAIN BELT COMPANY

"MADE TO ORDER"

for Oil Field Drilling

REX® A.P.I. CHAINS

These famous rotary drilling chains are especially built for oil field needs. Five Rex features make them perennial favorites around the drilling rigs.

★ **BALANCED DESIGN**—strength of chain parts is properly balanced for longer life . . . lighter weight.

★ **MAXIMUM WEAR RESISTANCE**—high carbon alloy steel, heat treating, case hardening, all combine to produce a chain that lasts longer.

★ **FORCE FIT ASSEMBLY**—parts machine assembled into famous Rex Unit Link. Each link exactly alike—they retain uniformity under toughest conditions.

★ **EFFECTIVE LUBRICATION**—oil holes in bushings assure placing of oil where it's really needed.

★ **EASY TO TAKE APART**—Rex 3-diameter pin makes assembly and disassembly easy. No need for heavy driving or use of drift pins.

NO OTHER PUMP COMBINES ALL THESE!

The Rex Self-priming Oil Field Utility Pump combines 5 great features that add up to *outstanding performance—outstanding value.*

★ Extremely Simple Design.

★ All Wearing and Moving Parts accessible with removal of one cover plate.

★ Lightweight...easily portable, yet really sturdy.

★ Simplest, most positive leakproof seal ever designed.

★ Patented Rex Adjustable Air Peeler assures "new pump" efficiency for its entire life.

See it at your nearest supply store. Rex Oil Field Sales Offices are located in these cities: NEW YORK • TULSA • DALLAS • HOUSTON MIDLAND • LOS ANGELES

CHAIN BELT COMPANY

BALDWIN-DUCKWORTH DIVISION
SPRINGFIELD 2, MASS.

REX CHAIN & TRANSMISSION DIVISION
MILWAUKEE 4, WIS.

REX CONSTRUCTION MACHINERY DIVISION
MILWAUKEE 4, WIS.

Will Boiler Tube Failure Sabotage Your Production This Month?

It can happen *any* day. Scale deposits may be forming in your boiler tubes *right now* . . . adding layer on layer . . . building up for the failure that is sure to come!

But whatever day failure occurs . . . you can be sure of one thing. It's going to be expensive! Often, many times more costly than *proper* corrective treatment.

Drew water treatment service *prevents* tube failures. First, a Drew engineer obtains complete operating and water data at your plant. Then these data are analyzed in the modern Drew Laboratories, and specific recommendations for corrective treatments are made. Finally, Drew engineers make frequent and continuous check-ups at your plant. This three-step procedure gives you the best results at the lowest cost.

Thoroughness of investigation and proper treatment have made Drew one of America's fastest growing water treatment companies. Industry's most respected names avail themselves of Drew Boiler Water Treatment and Service. Do the same. Consult the nearest Drew engineer or write for information.

Send for the new, illustrated DREW ORGANICS Folder describing the use of organics in modern Boiler Water Treatment. Write today.

POWER DREW CHEMICALS

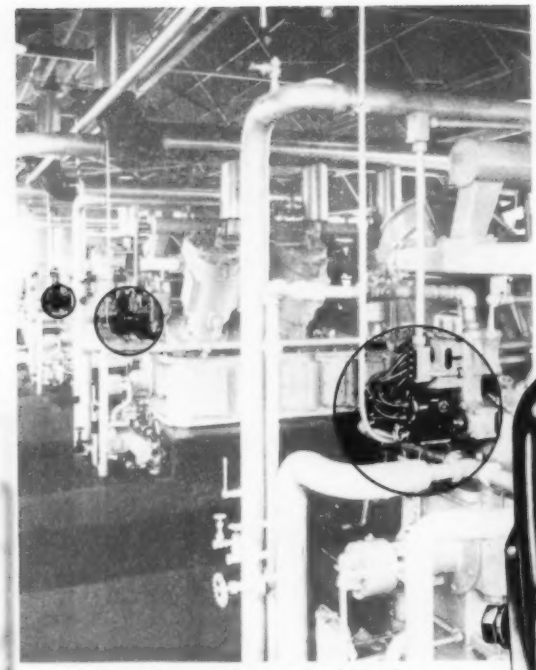
Power Chemicals Division

E. F. DREW & CO., INC.

15 East 26th Street, New York 10, N. Y.

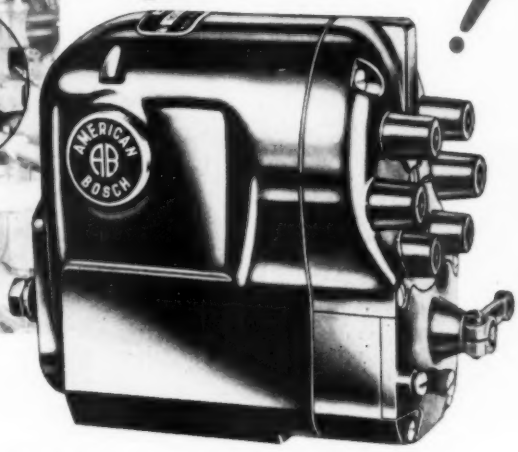
DREW PRODUCTS

Nationwide Service in Boiler Water and Cooling Water Conditioning



Shown above, an American Bosch High Tension Magneto installation at the Sun Ray Oil Company's re-cycling plant, Benton, La.

KEEPING HORSEPOWER HUMMING in the OIL INDUSTRY!



AMERICAN BOSCH MAGNETOS

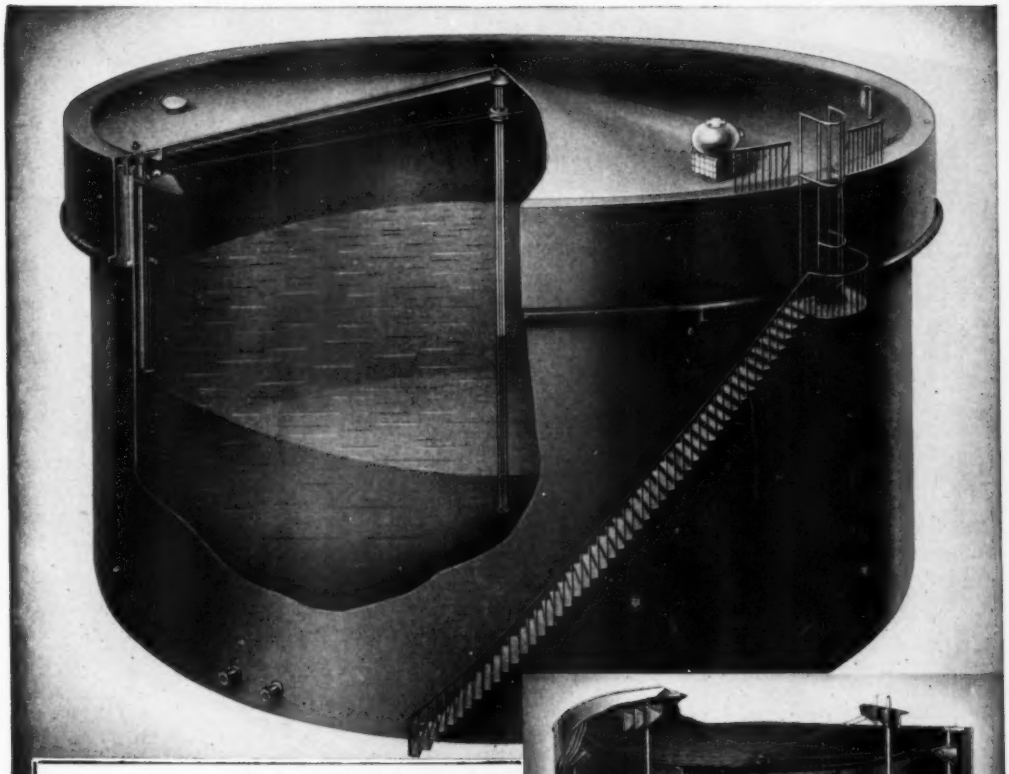
American Bosch Super Powered Magnetos give engines the constant, faultless sparks that assure quick starting and prevent costly ignition tie-ups in profit-producing Oil Industry equipment. Add to these advantages, more *years* of trouble-free ignition in the toughest, continuous operation, and you'll appreciate why these famous Magnetos are used widely, not alone as replacements throughout the Oil Industry, but the choice of many leading manufacturers as original equipment on engines in drilling, producing, pipeline and refinery services.

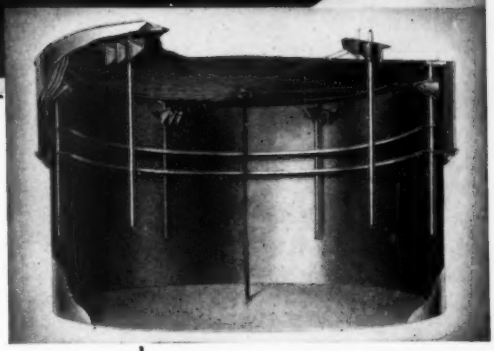
You can have this maximum spark efficiency and matchless dependability on all your present, spark-ignited engines with either high or low tension ignition systems. For, American Bosch's outstanding electrical and mechanical features are inherent in both high and low tension applications of these power-packed Magnetos. Moreover, there's a generous trade-in allowance on the old magnetos you replace . . . Ask for the cost-reducing, profit-protecting facts and the name of your nearby American Bosch Distributor.

American Bosch

MAGNETOS • GENERATORS • VOLTAGE REGULATORS • IGNITION COILS
ELECTRIC WINDSHIELD WIPERS • DIESEL FUEL INJECTION EQUIPMENT

AMERICAN BOSCH CORPORATION • SPRINGFIELD 7 • MASS.





INSIDE STORY

ON VAPOR-SAVING WITH THE GRAVER EXPANSION ROOF

Cut-away for your inspection is this Graver Expansion Roof Tank. Here you see the details of its operation which dependably conserves the volatile elements of gasoline . . . so critically important today! This Graver design—approved by Underwriters' Laboratories—has a record of unfailing operation throughout the petroleum industry during the decade since it was first introduced.

Inset above shows mechanism by which *all-weather* stability is attained in the Graver Expansion Roof. The functional perfection of this design keeps *Conservation at Work* day and night in any climate . . . all year 'round.

FABRICATED PLATE DIVISION

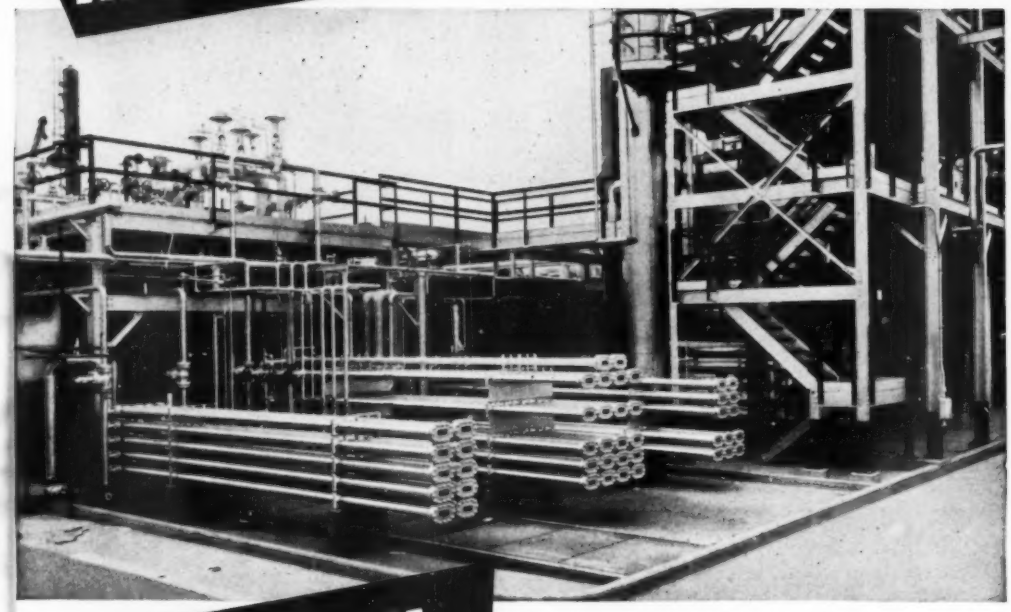
GRAVER TANK & MFG. CO., INC.

EAST CHICAGO, INDIANA

NEW YORK • CHICAGO • PHILADELPHIA • WASHINGTON
DETROIT • CINCINNATI • HOUSTON
CATASAUQUA, PA. • SAND SPRINGS, OKLA.

GRAVER

Easier Maintenance in your plant



with BROWN FINTUBE *sectional hairpin heat exchangers*

● Brown Fintube Sectional Heat Exchangers make maintenance easier and less costly. The integral welded-on fins *positively can not* work loose from the center tube. Their efficient heat transfer at low "skin" temperatures, and the absence of baffles and stagnant areas in the exchanger, minimize coking and fouling.

The ingenuous head end assembly, employing a ring joint seal, and the easy to handle rear end cover plate permit an exchanger to be opened, a clean hairpin substituted, and the exchanger put back on stream again in less than ten minutes. For top operating efficiency and easier, less costly maintenance, write for Brown Fintube ***Bulletin No. 481.***

THE BROWN FINTUBE CO.

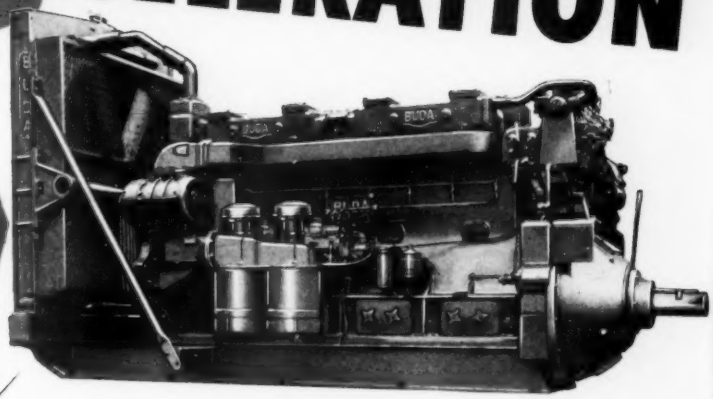
Elyria, Ohio

Sectional Hairpin Heat Exchangers
Tank Suction and Line Heaters
Fintube Heaters for Bulk Storage Tanks
Indirect Process Air Heaters
Fintube Heaters for Processing Tanks
Integrally Welded Fintubes for Any Heating, Cooling or Heat Transfer Service

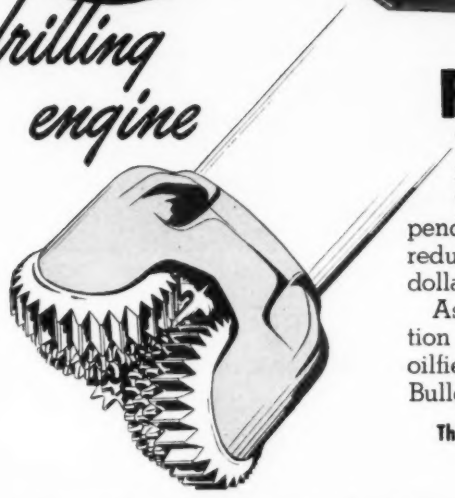
NEW YORK • BOSTON • PHILADELPHIA • WILMINGTON • PITTSBURGH • BUFFALO • CLEVELAND • CINCINNATI • DETROIT • CHICAGO
ST. PAUL • ST. LOUIS • MEMPHIS • BIRMINGHAM • NEW ORLEANS • TULSA • HOUSTON • LOS ANGELES • SAN FRANCISCO

POWER ACCELERATION

2505 SERIES



drilling engine

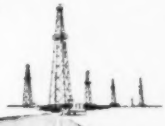


FASTER ROUND TRIPS

Buda 2505 Series drilling engines keep your bit rotating on bottom a greater percentage of the time . . . their acceleration and tremendous, dependable power makes faster round trips possible . . . reducing the time bit is off bottom. This means more dollars to you.

Ask your nearby Buda Distributor for full information on the cost-saving "2505" engine . . . The only oilfield engine with the "Fuecomizer Kit." Write for Bulletins and data. No obligation.

The Buda Company, Harvey, Illinois.



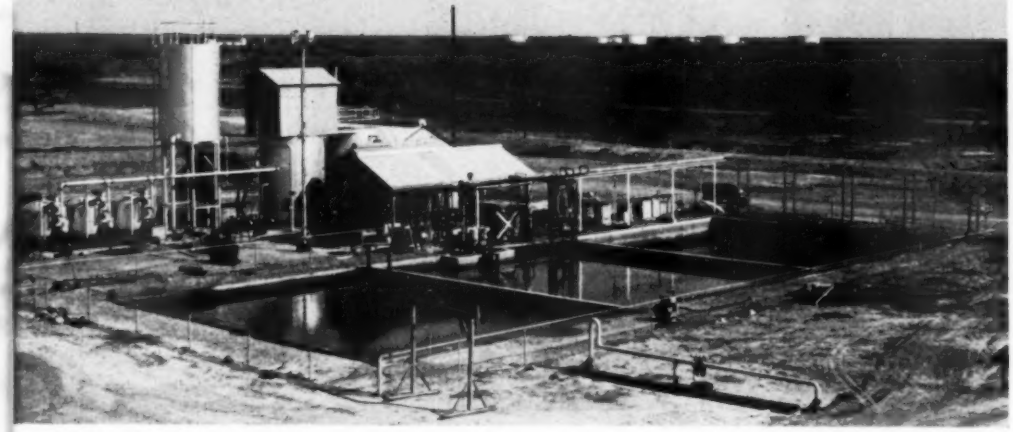
Wherever There's Oil, There's Buda . . .
Engines and Service

BO-19

BUDA

BUDA Oilfield Distributors are located in: Dallas • Tulsa • Los Angeles • Houston • Oklahoma City • Seminole • Wichita Falls • Shreveport • Bakersfield • Tinsley • Pampa • Great Bend Long Beach • Kilgore • Mt. Carmel, Ill. • Alice • Odessa • Casper • Lafayette • Artesia • Denver • Ulysses • Brookhaven • New York City (Export) and in Canada at Calgary and Edmonton

How To Get Full Capacity From Your Salt Water Disposal Wells!



DISPOSAL PLANT LAYOUT, MAGNOLIA PETROLEUM CO., PREMONT, TEXAS

YOU can get maximum capacity and satisfaction from your salt water disposal wells only if you maintain the ability of the formation to receive the water. The way to do that is by treating salt waters with Infilco equipment.

REMOVES SUSPENDED MATTER *by coagulation and filtration.*
STABILIZES THE WATER *to prevent scaling.*
CONTROLS CORROSION *to prevent production of insoluble products.*
STERILIZES *to prevent growth of bacterial gel on the formation face.*
PROVIDES FREEDOM FROM DISSOLVED SUBSTANCES *that would react with the reservoir water to produce a precipitate in the formation.*

Infilco installations from coast-to-coast are treating over ONE BILLION GALLONS of water *every day!* Call in the nearest Infilco Field Engineer or write our executive offices in Tucson for equipment recommendations.

SERVING THE OIL INDUSTRY WITH WATER CONDITIONING EQUIPMENT THAT'S

Quality Engineered for Quality Performance

INFILCO INC.
TUCSON, ARIZONA
WITH OFFICES IN PRINCIPAL CITIES

INFILCO
• BETTER WATER CONDITIONING AND WASTE TREATMENT SINCE 1894 •

WORLD'S LEADING MANUFACTURERS OF WATER CONDITIONING AND WASTE TREATING EQUIPMENT

Thermoid
Industrial
Rubber Products
Quality Value Service

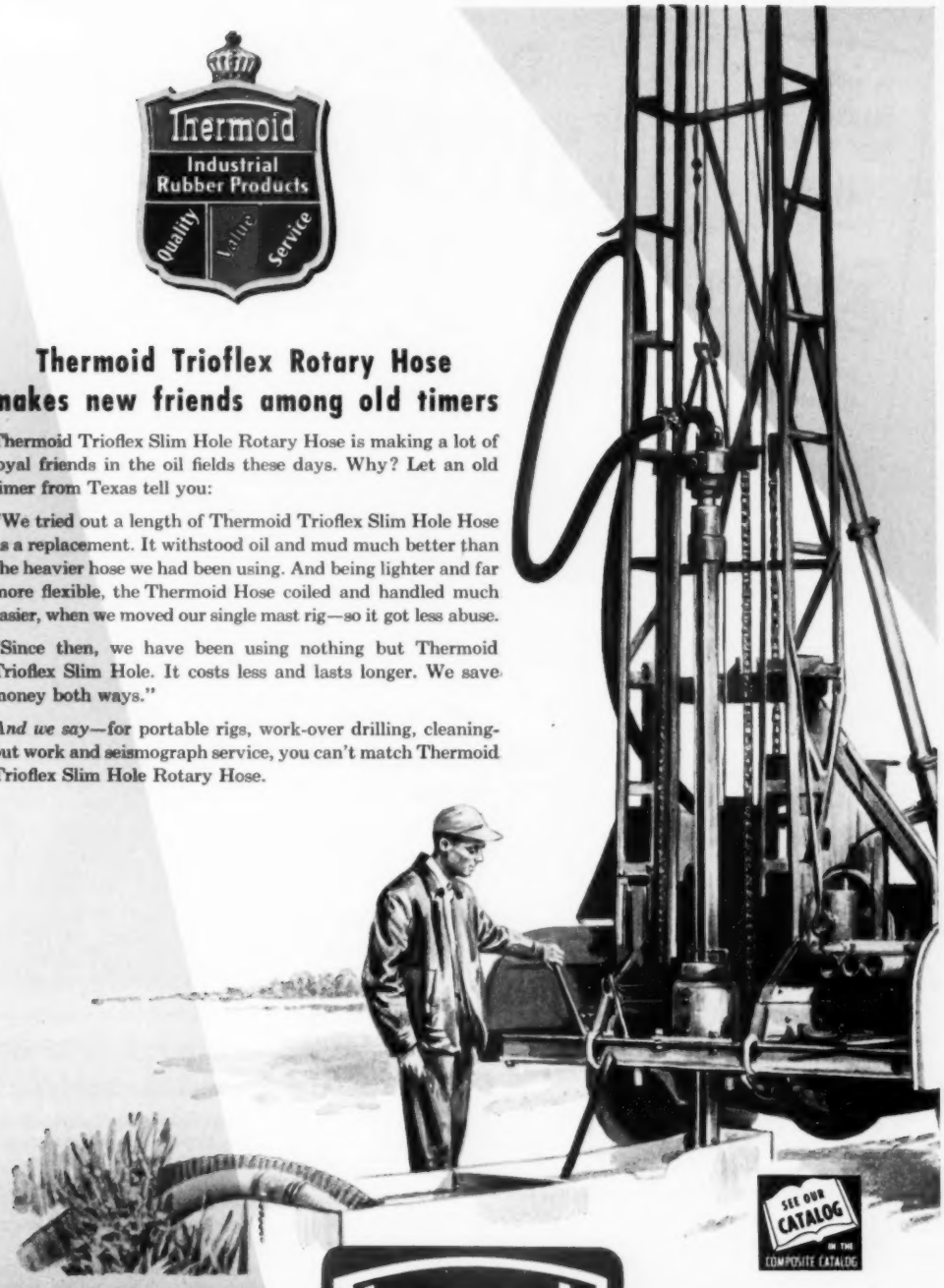
Thermoid Trioflex Rotary Hose makes new friends among old timers

Thermoid Trioflex Slim Hole Rotary Hose is making a lot of loyal friends in the oil fields these days. Why? Let an old timer from Texas tell you:

"We tried out a length of Thermoid Trioflex Slim Hole Hose as a replacement. It withstood oil and mud much better than the heavier hose we had been using. And being lighter and far more flexible, the Thermoid Hose coiled and handled much easier, when we moved our single mast rig—so it got less abuse.

"Since then, we have been using nothing but Thermoid Trioflex Slim Hole. It costs less and lasts longer. We save money both ways."

And we say—for portable rigs, work-over drilling, cleaning-out work and seismograph service, you can't match Thermoid Trioflex Slim Hole Rotary Hose.



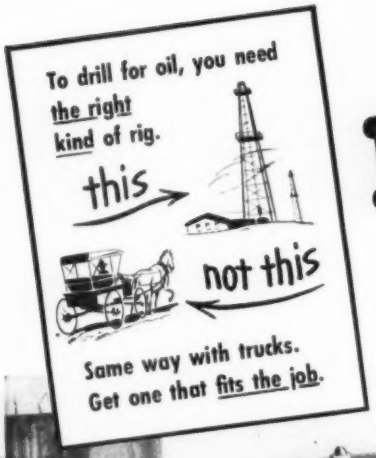
SEE OUR CATALOG IN THE COMPOSITE CATALOG

Thermoid

Powerflex Rotary Hose • Trioflex Slim-Hole Rotary Hose • Mud-Flo Slush Pump Hose • Flexible Discharge Units • F.H.P. and Multiple V-Belts • Oil Country Flat Belting

Wire Line Turn Backs • No-Wip Line Savers • Stuffing Box Rings • All Types of Hose • Molded Specialties • Brake Blocks

Thermoid Company • Offices & Factories: Trenton, N. J., Nephi, Utah



Dependable DODGE TRUCKS are "Job-Rated" for extra power

Switch to Dodge "*Job-Rated*" trucks and get more power for your off-the-highway operations—plus top performance and top economy!

New Dodge "*Job-Rated*" trucks are the most powerful in Dodge history. You get better-than-ever hauling efficiency because of power increases up to 20%. For example, the twin carburetion and exhaust system on big 3-ton models gives you 145 hp.—more power than ever with greater economy!

You can move bigger loads, too—with either 4- or 6-wheelers. You get new comfort—plus new handling ease on and off the road. On top of all this, you get famous Dodge *dependability* in a rugged truck that's built to stay on the job and out of the shop.

See how much you'll save with a powerful Dodge truck that's "*Job-Rated*" for your hauling jobs. See your Dodge dealer.

"Job-Rated" TRUCKS DO THE MOST FOR YOU

How Dodge trucks are "*Job-Rated*" for oil field and refinery hauling jobs

A Dodge "*Job-Rated*" truck is engineered *at the factory* to fit a specific job . . . save you money . . . last longer.

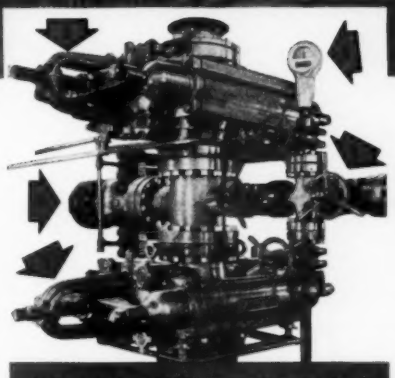
Every unit from engine to rear axle is "*Job-Rated*"—factory-engineered to haul a specific load over the roads you travel and at the speeds you require.

Every unit that SUPPORTS the load—frame, axles, springs, wheels, tires, and others—is engineered right to provide the strength and capacity needed.

Every unit that MOVES the load—engine, clutch, transmission, propeller shaft, rear axle, and others—is engineered right to meet a particular operating condition.

STANDING BETWEEN YOU AND DISASTER

...DEPENDABLE DRILLING CONTROL SYSTEM



1. Cameron Type "QRC" Pressure-Operated Blowout Preventer equipped with blind rams. 2. Cameron Type "HCR" Pressure-Operated Flowline Gate Valve. 3. Cameron Type "QRC" Pressure-Operated Blowout Preventer, equipped with pipe rams. 4. Cameron Mud Line Pressure Gauge. 5. Cameron Flex-Seal Mud Line Valves in mud choke manifold with Cameron Positive Choke.

With an up-to-date Cameron Pressure-Operated Drilling Control Manifold under your derrick floor, you may rest assured that you have provided the most dependable mechanical insurance against loss of control. And this insurance goes all the way . . . protecting you against loss of control while pipe is in the hole, out of the hole, through the flowline, and through the choke line.

No other drilling control units offer so much protection. The Cameron "QRC" Pressure-Operated Blowout Preventer and "HCR" Flowline Valve provide swift closure of rams and gate; remote-control operating valves within easy reach of the driller; patented self-feeding ram and gate packing for a positive seal and to permit pipe rotation through closed rams; high ratio of closing pressure to well pressure (8 to 1), and quick ram change design which permits changing ram size in a matter of minutes.

Don't wait for a blowout to focus attention on your drilling control equipment. Check now to make sure that you have the protection of all of Cameron's drilling safeguards.

Cameron 1st *name in drilling control*

CAMERON IRON WORKS, INC.

P. O. Box 1212, Houston, Texas
Export: 74 Trinity Place, New York, N. Y.
Represented in the sterling area by: British Oil Field Equipment Co., Ltd., London, S.W.1

CORROSION CRIPPLES-MORE WAYS THAN ONE

Valuable products as well as vital equipment are threatened

Corrosion takes its toll in more ways than one—it can cause costly, hard-to-get equipment—wastes man-hours while plants are shut down for repairs—and causes loss of vitally-needed products through contamination.

Every industry suffers from corrosion in some form, yet much of this waste can be avoided by taking these steps:

1. Check manufacturing equipment, storage tanks, and other items exposed to corrosive fumes, acids, alkalies, or moisture.
2. Arrange to protect them with AMERCOAT—the corrosion resistant coatings, each built to conquer specific industrial corrosion problems.

Manufacturers in nearly every industry have found that it pays to protect — protect with AMERCOAT.

AMERCOAT CORPORATION

A division of
American Pipe and Construction Co.

5600 FIRESTONE BLVD., SOUTH GATE, CALIFORNIA

FOLLOW THE LINE OF *most* RESISTANCE

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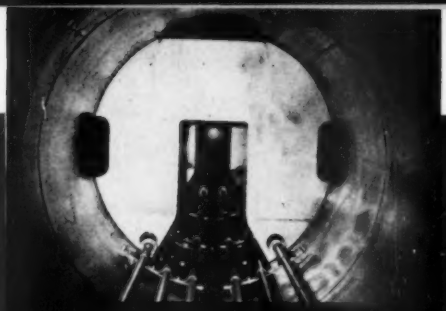
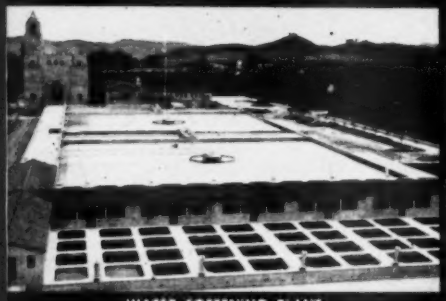


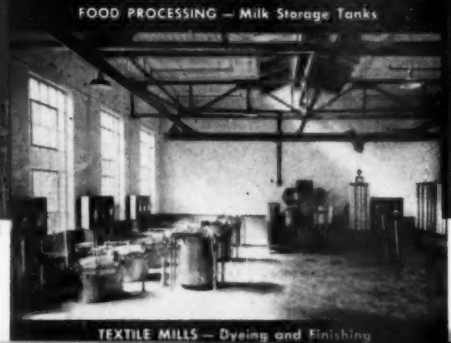
CHEMICAL PLANTS — Caustic Soda Tank

PETROLEUM REFINING — Columns and Piping



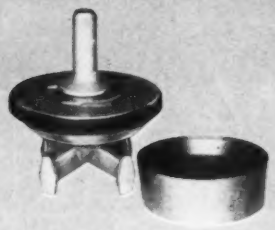
WATER SOFTENING PLANT
(Photo Courtesy Metropolitan Water District of Southern California)

FOOD PROCESSING — Milk Storage Tanks



TEXTILE MILLS — Dyeing and Finishing

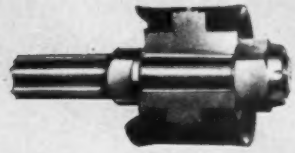
For all IDEAL pumps and pumps of other manufacture



IDEAL Valves and Seats for maximum fluid flow.

"Nationaloy" liners for regular service.

API Rods
"Blue-Stripe" rods both API & GT for regular service.



"GT" Pistons and rods for higher pressures, more severe service.

"Blue-Chrome" rods for highly corrosive conditions.

V-Ring Packing.

Cap and Head Gaskets.

MEMO:

IDEAL fluid end parts are always available at your National Supply Store

The familiar Blue-and-Yellow label identifies these IDEAL Fluid End Parts at your National Supply Store. Readily available for IDEAL pumps and pumps of other manufacture. Check on your requirements with the National Supply representative, or write for catalog 357-A.

- *NATIONAL OIL FIELD MACHINERY AND EQUIPMENT*
- *SPANG STEEL PIPE*
- *SUPERIOR & ATLAS ENGINES*

THE NATIONAL SUPPLY COMPANY

GENERAL SALES OFFICES: TOLEDO, OHIO

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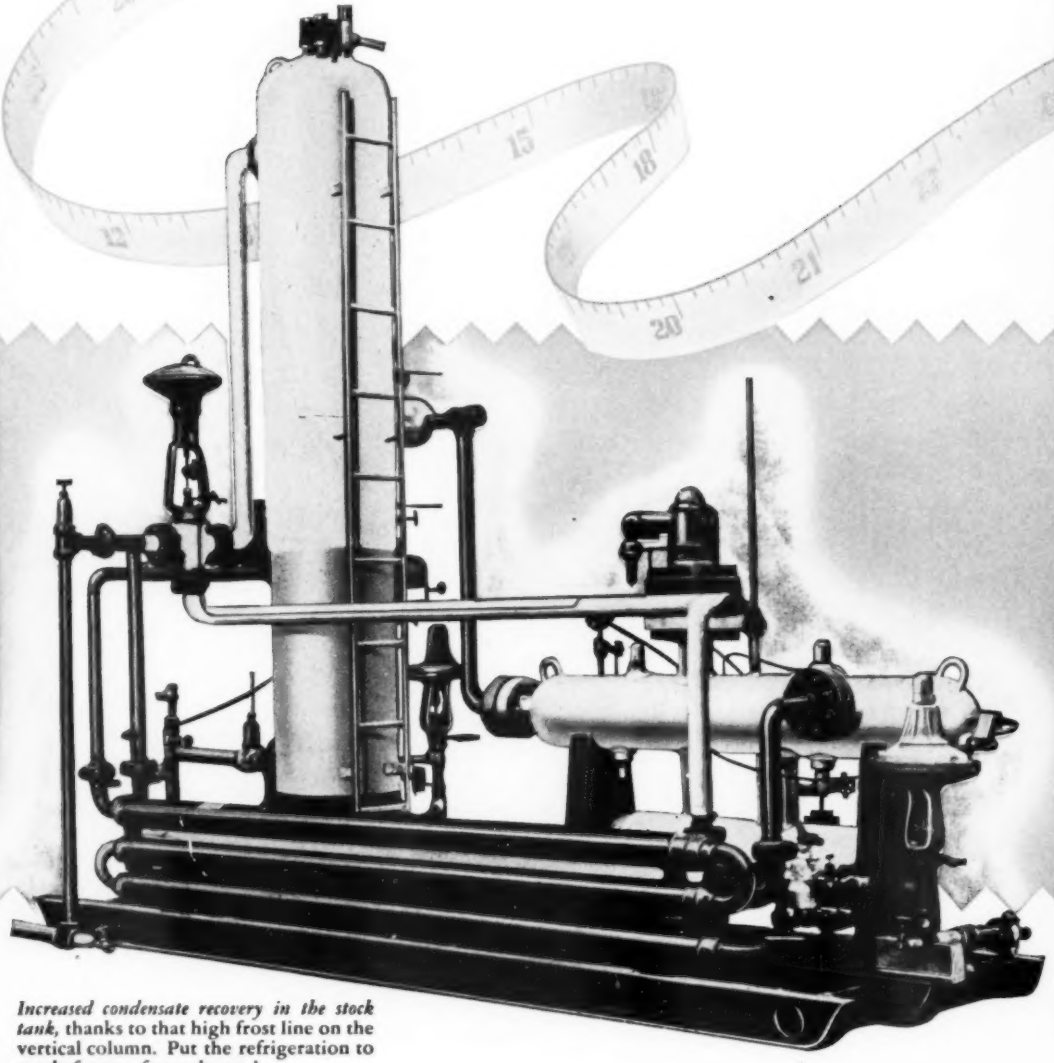
NATIONAL BLUE PRODUCTS

"Tailored"



Increased condensate recovery in the stock tank, thanks to that high frost line on the vertical column. Put the refrigeration to work *for you,* for a change!

BLACK, SIVALLS & BRYSON, INC.

OIL AND GAS EQUIPMENT DIVISION

Adv. Dept., Rm. 15A 2131 Westwood Blvd. Oklahoma City, Oklahoma

to Meet Your Problem

Low Temperature Separation for ANY Application! -- Just Group Only the BS&B Component Parts You Need into ONE Compact, Efficient Unit!

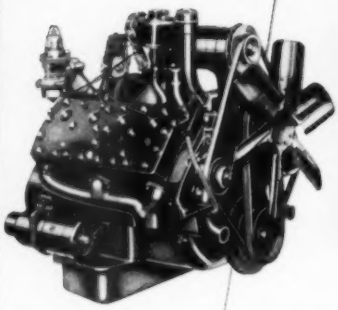
SAVE MONEY Up to 35% increase in the hydro-carbon condensate recovered from well-stream! Dehydrate gas for sale...or eliminate hydrates in gathering lines...where allowable pressure drop across the plant provides sufficient refrigeration. And where refrigeration is inadequate, the BS&B Low Temperature Separator dehydrates sufficiently to eliminate line heaters in gathering system!

DESIGN BALANCE Permits use of standard units *or parts,* as problem requires. System includes free-water knockout, pressure-reducing valve, vertical separator with integral heat exchanger, temperature controls, heat exchanger with or without skids and piping as your problem requires. Units can be furnished for *any applicable working* pressures.

PAYS OUT QUICKLY Returns your investment with increased stable condensate recovery . . . up to 35%! Equipment may be re-arranged or supplemented to use during life of well. Or it may easily be salvaged. Standard oil field construction requires little maintenance. Call your BS&B Man today for the full story . . . or write for free illustrated catalog.

S13 BS&B

LOW TEMPERATURE SEPARATORS



Power for Profits...with FORD POWER!

Typical of the application of Ford Power in the petroleum industry is this oil field hoisting unit, product of the Hopper Machine Works, equipped with 50-foot telescoping pipe mast for servicing wells. It is powered with a Ford Power Unit using the Ford "337" V-8 Industrial Engine with 5-speed transmission.

● When you standardize on Ford Power for your equipment you are assured of the **RIGHT** Power, with the **RIGHT** Features and the **RIGHT** Service—the **RIGHT** combination for more sales, more profits.

Ford Industrial Engines and Power Units are available in five great models from 120 to 337 cu. in. displacement . . . a four, two sixes and two V-type eight-cylinder engines. Every unit is individually tested and ready to run.

Right Features, too—with Ford Industrial Engines and Power Units you have available a complete line of special Ford equipment and accessories to meet specific operating requirements.

Our experienced Sales Engineers are at your service in developing engineering recommendations for the most efficient use of Ford Industrial Power in your application.

Ford

INDUSTRIAL ENGINES AND POWER UNITS

What's more, Ford Power assures you of *Right Service* . . . as near as the nearest Ford Dealer. Result—such important operating advantages as replacement parts availability, reducing parts inventory costs . . . ease of servicing, minimizing costly "down time."

For equipment powered for profits, specify Ford Industrial Engines and Power Units.

Here are some typical Ford-powered oil industry applications:

Drilling Rigs . . . Hoists . . . Draw Works
Pipe Line Forming Machines . . . Welders
Portable Lighting Sets . . . Well Cementers

YOUR JOB IS WELL-POWERED WHEN IT'S FORD-POWERED

Industrial Engine Department, FORD MOTOR COMPANY
15050 Woodward Ave., Highland Park 3, Michigan

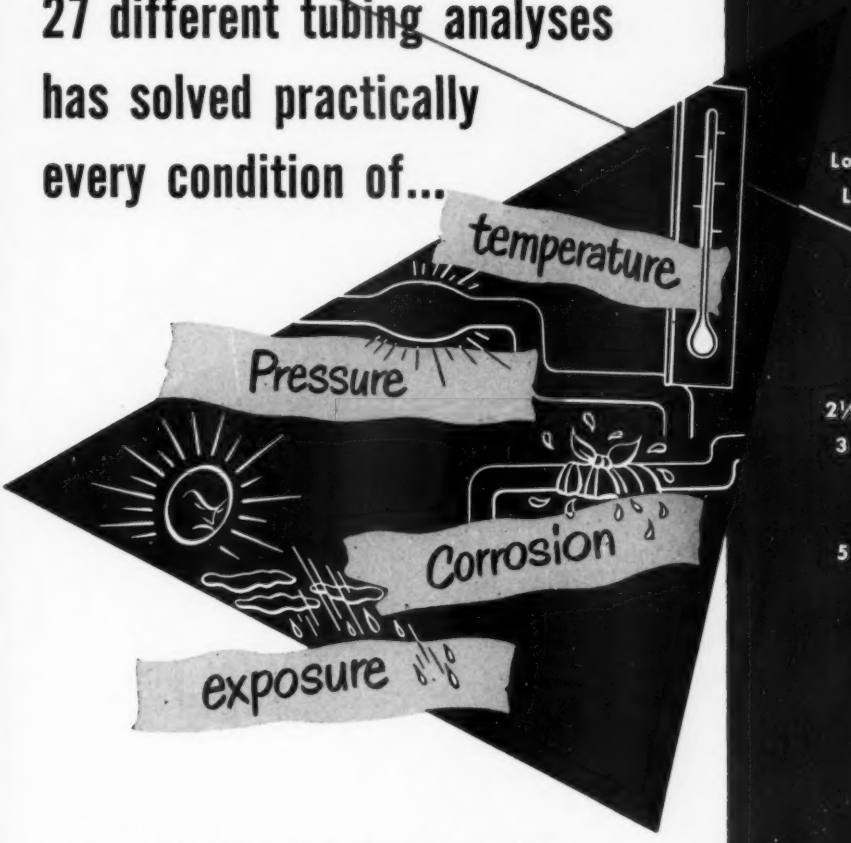
I am interested in Industrial Power for: _____
(state your application)

Send me new 1951 literature on Ford Industrial Power (cu. in. dipl. and cylinders as shown).
☐ "120" 4-Cyl. ☐ "226" 6-Cyl. ☐ "239" V-8 ☐ "254" 6-Cyl. ☐ "337" V-8

Firm Name _____
(Please print)
Attention of _____
Street _____
City _____ *Zone* _____ *State* _____ 1

INDUSTRIAL ENGINE DEPARTMENT
Tractor & Industrial Engine Division
FORD MOTOR COMPANY
Highland Park, Michigan

One of these 27 different tubing analyses has solved practically every condition of...



Low Carbon
Low Carbon, ½ Mo
Low Carbon, 1 Mo
½ Cr, ½ Mo
1 Cr, ½ Mo
1¼ Cr, ½ Mo
2 Cr, ½ Mo
2¼ Cr, 1 Mo
2½ Cr, ½ Mo, ¾ Si
3 Cr, ½ Mo, 1¼ Si
3 Cr, 1 Mo
5 Cr, ½ Mo
5 Cr, ½ Mo, 1½ Si
5 Cr, ½ Mo, Ti
6 Cr, ½ Mo
7 Cr, ½ Mo
8 Cr, 1 Mo
9 Cr, ½ Mo
9 Cr, 1 Mo
12 Cr, Al
17 Cr
27 Cr
18-8
18-8 Ti
18-8 Cb
18-8 Mo
25-20

● Here at Tubing Headquarters, we have long maintained a razor-sharp staff of specialists—men with many years of experience in solving refinery tubing problems.

These specialists have had a tremendous file of data to help them. Some of it came from our own laboratories. But the most valuable data came from actual case histories . . . and constant observation of refineries throughout the country.

To cope with numerous problems, we developed 27 different analyses that we frankly think have helped to solve almost any refinery tubing problem. We've watched these tubes in service—and we've seen them do a good job.

When you plan for future projects bring your tubing questions to National Tube Company. Most of the time, a problem that is new to you will be a simple matter of recorded history to us. All of this bed-rock experience is yours for the asking. We will be glad to help you.

NATIONAL TUBE COMPANY, PITTSBURGH, PA.

(TUBING SPECIALTIES DIVISION)

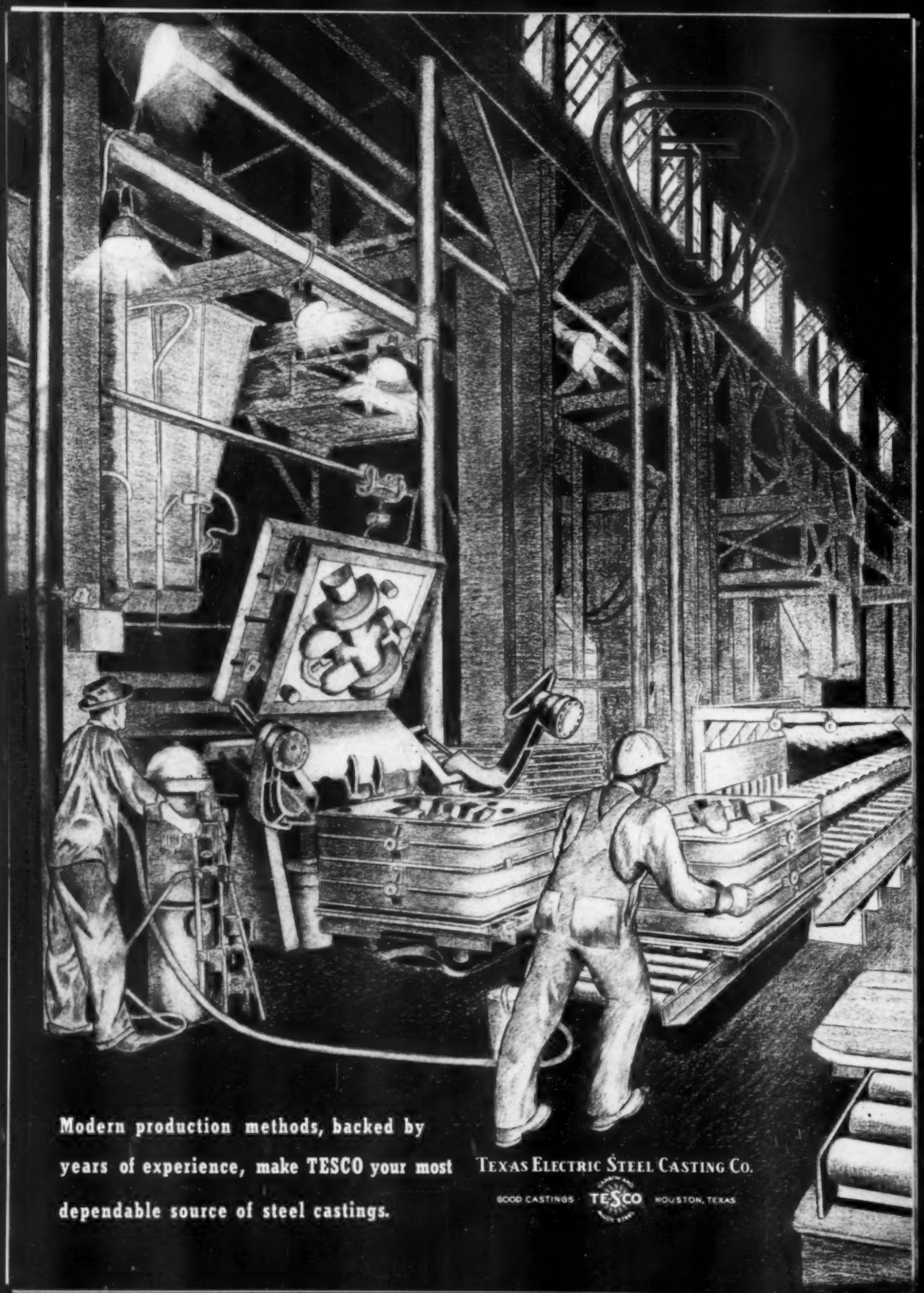
COLUMBIA STEEL COMPANY, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS

UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

NATIONAL SEAMLESS PIPE AND TUBES

UNITED STATES STEEL

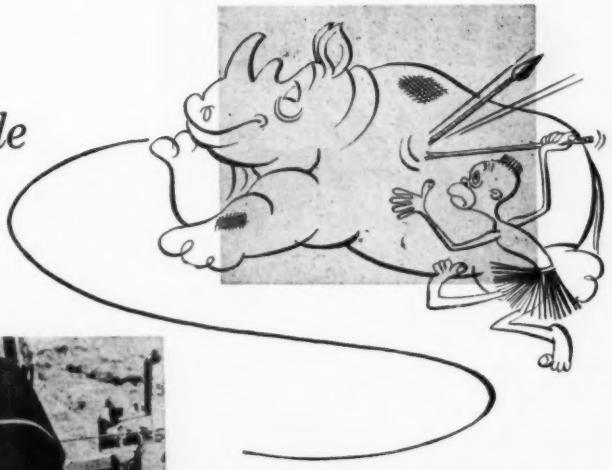


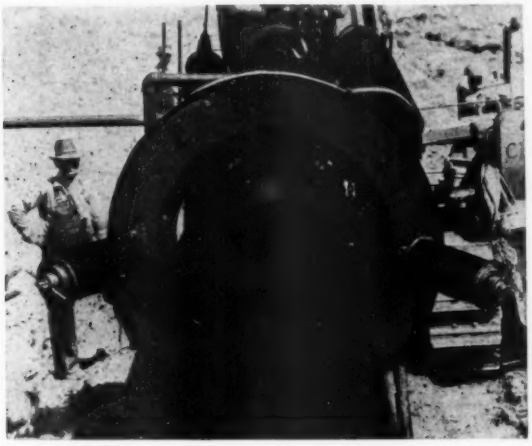
Modern production methods, backed by years of experience, make TESCO your most dependable source of steel castings.

TEXAS ELECTRIC STEEL CASTING CO.

GOOD CASTINGS · TESCO · HOUSTON, TEXAS

Like the Rhino's tough hide that protects what's inside...





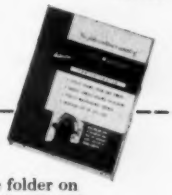
Johns-Manville Asbestos Felt protects oil and gas pipe lines

MORE than 100,000 miles of oil and gas pipe lines are now protected by Johns-Manville Asbestos Pipeline Felt—*the only type of wrapper that has survived over 50 years of service in all types of soils.*

Johns-Manville Asbestos Felt is a sturdy, inorganic product. It has the thickness and toughness necessary for shielding pipeline enamels from earth load and soil stresses. It is resistant to rot and decay, and to acid and alkali soils. It permits the protective enamel coating to properly function against corrosion.

Johns-Manville Asbestos Felt is flexible. It wraps easily without cracking. It guards enamel from impact during installation of field-wrapped pipe, or during transportation and installation of mill-wrapped pipe.

There are economic advantages, too. In addition to reducing maintenance expense, Johns-Manville Asbestos Felt adds many years of life to the pipeline. For further information and a sample of Johns-Manville Asbestos Pipeline Felt, mail the coupon below.



Johns-Manville
Asbestos
PIPELINE FELT

Johns-Manville
Box 290, New York 16, N. Y.
Please send me a copy of the sample folder on Johns-Manville Asbestos Pipeline Felt, PP-22A.

Name_____

Address_____

City_____ Zone____ State_____

FISHER®

Teflon*

V-RING PACKING CONVERSION KIT

A *Complete*

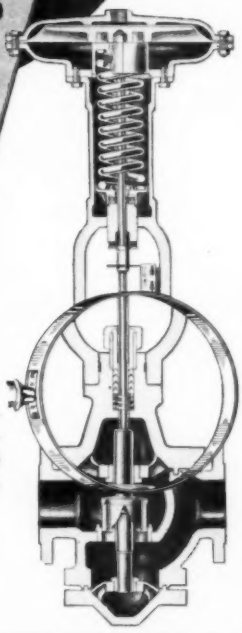
PACKAGED UNIT

This complete packaged Fisher Teflon V-Ring Conversion Kit converts a standard Fisher stuffing box unit to Fisher Teflon V-Ring Packing. It offers prompt service, guarantees a true fit and insures damage-free delivery.

When ordering, be sure to furnish the valve serial number found stamped on the patent plate attached to yoke or body.

* Teflon is the trade name of E. I. DuPont de Nemours & Co.

FISHER GOVERNOR COMPANY
Marshalltown, Iowa

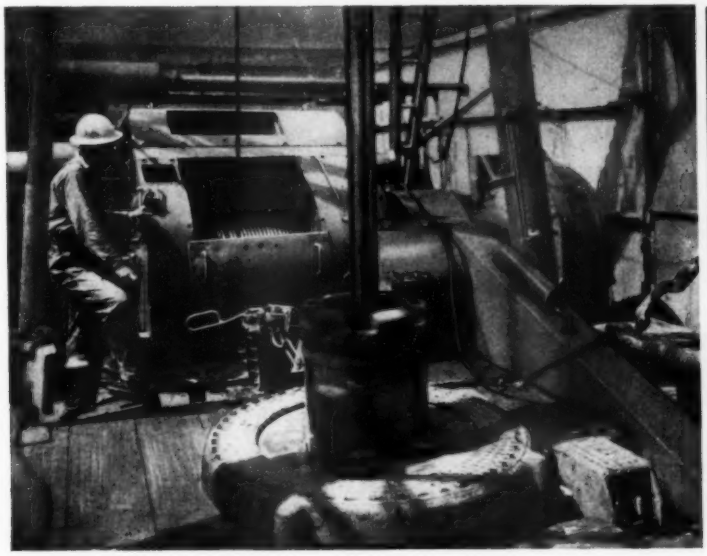


Fisher Teflon V-Ring Packing is furnished as standard on new Fisher Diaphragm Motor Valves.

FISHER®

WORLD LEADER IN THE MANUFACTURE OF PRESSURE REGULATORS AND IN RESEARCH FOR BETTER PRESSURE CONTROL

WIRE ROPE



ROEBLING ALL-PURPOSE SLINGS with the Tapered Sleeve Splice come to you ready for the job. They cost less than tucked splices . . . have the full strength of the rope. Send for the full story.

In the oil fields Roebling "Blue Center" Preformed is tops for service and savings

"BLUE CENTER" STEEL wire rope is an exclusive Roebling development. It has to pass the most stringent tests for strength, fatigue and abrasion resistance . . . gives rope the extra long life that spells important economies. Besides, Roebling Preforming assures you top performance on the job. "Blue Center" Preformed is easy to handle . . . has better spooling qualities . . . reduces vibration and whipping.

Roebling makes a complete line of wire rope . . . makes the right grade, and construction for every installation. Have your Roebling Field Man help choose the *right* rope for your equipment. Get his advice on the correct use and maintenance of wire rope. It is based on performance records on thousands of installations. John A. Roebling's Sons Company, Trenton 2, New Jersey.

ROEBLING

DISTRIBUTED BY THE NATIONAL SUPPLY COMPANY
REPUBLIC SUPPLY COMPANY

A "K" Monel doctor blade in use on a soap flaker dryer roll. After 7 months of highly satisfactory service, this blade was transferred to rolls used for polishing soap, setting a record for doctor blade longevity in the plant.

The Doctor Was a Headache

...until they tried "K" MONEL

In a soap flake plant, flaker roll doctor blades were a source of considerable trouble and expense.

The blades were operated against a cast iron cooling roll, 5 ft. in diameter with a 90 in. face, which handled 72,000 pounds of soap every 24 hours.

Although made of the finest Swedish steel, doctor blades had to be honed every hour, and reground every 24 hours. It took only ten minutes to change a blade, but in that short time 500 pounds of soap production were lost.

After putting up with the problem for some time, plant engineers decided to try doctor blades made of "K" Monel®.

Results? Judge for yourself! Here is what the plant engineers reported:

1. "K" Monel doctor blades (0.031 in. thick by 4 in. wide) required honing only once in 24 hours.

2. "K" Monel blades gave 27 continuous days of service before needing regrinding.

3. It took more than 7 months to reduce the width of a "K" Monel blade from 4 in. to 2¾ in.

Switching to "K" Monel doctor blades gave them 24 times more service between honings, 9 times more service between regrinds, and saved uncalculated production poundage formerly lost through frequent blade changes.

Not always, of course, can such spectacular gains be made merely by changing the material of a doctor blade. But here's something to remember —

There are special INCO Nickel Alloys for almost every doctor blade application . . . alloys that have a proved record of reducing maintenance costs and speeding production.

Find out more about these important alloys by asking for your copy of: "How to Get More Production from Doctor Blades." Right now, of course, INCO Nickel Alloys are being diverted more and more to defense production, so you may have to wait for the metal you want.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

EMBLEM OF SERVICE
NICKEL (INCO) ALLOYS

MONEL® • "K"® MONEL • "KR"® MONEL • "R"® MONEL • "S"® MONEL
NICKEL • LOW CARBON NICKEL • DURANICKEL®
INCONEL® • INCONEL "X"®

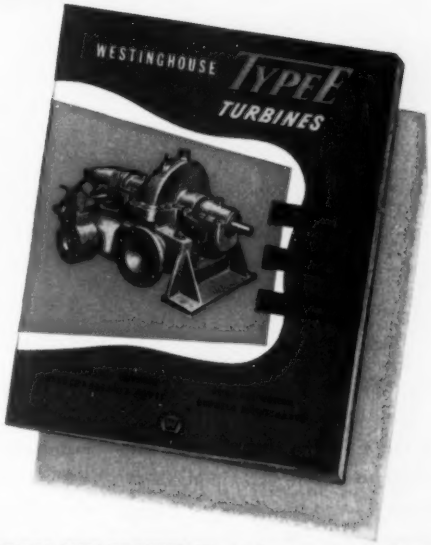
INDUSTRY'S STANDARD STEAM DRIVE!

For Continuous or Stand-by Operation...

Here's the general-purpose turbine that meets the increasingly rigid demands of modern industry. It's the Westinghouse Type E, designed to operate reliably and efficiently where the going is tough. Regardless of operating conditions, the Type E is built to give trouble-free, economical performance for long periods of continuous operation . . . or instant operation when used as a stand-by drive.

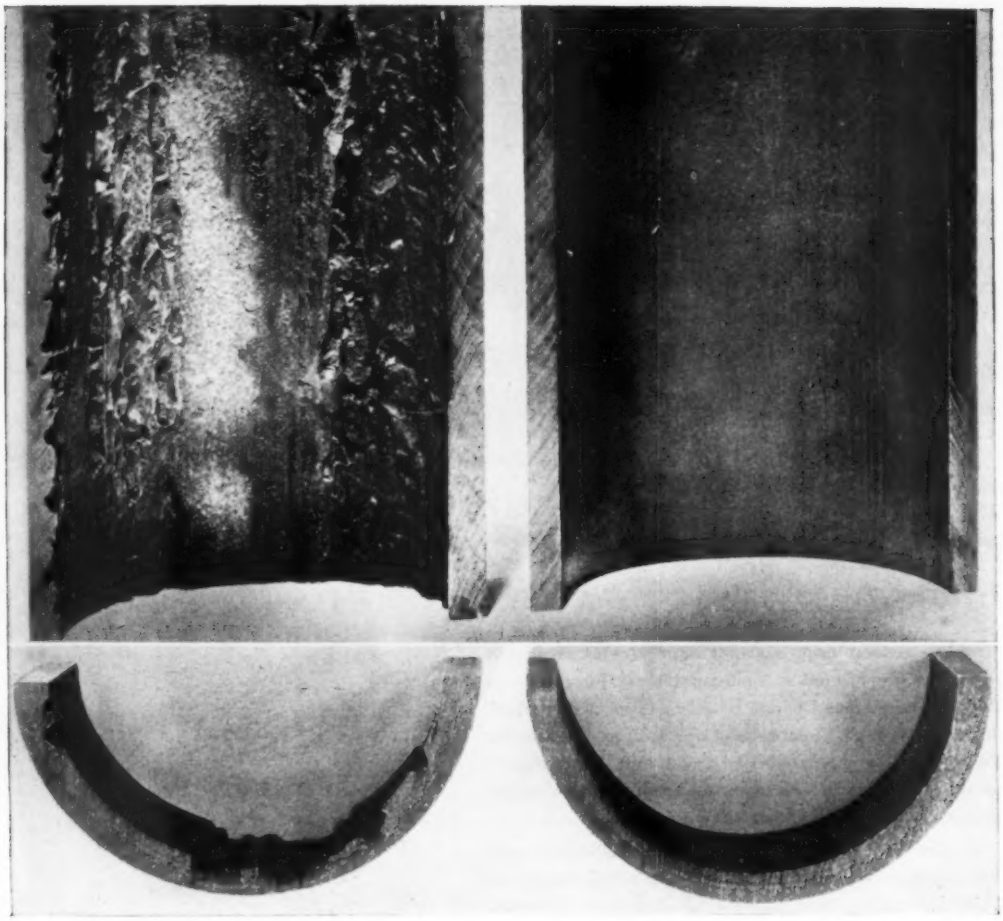
Wrapped up in one reliable unit are the best features of all Westinghouse drives . . . plus refinements and development features which are now standard on all Type E Turbines.

Weatherproof bearing seals, corrosion-resisting gland zones, centerline support for freedom of expansion and contraction, dual protection against overspeed, floating movement of governing and trip linkages, and parts interchangeability between wheel sizes are among the many advantages built into Type E drives. J-50526



WRITE FOR THIS BOOKLET. We invite your comparison . . . *on any count.* See your nearby Westinghouse representative for the full story. Ask him for Type E Turbine Book B-3896, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Penna.

YOU CAN BE SURE.. IF IT'S
Westinghouse
TYPE E Turbines



Don't Let Corrosion Steal Your Steel!

A major oil company coated the inside of 4-inch steel tubing with finishes based on VINYLITE Brand Resins. Each day, for five months, the pipe carried 100 barrels of oil and 5,000 barrels of high-iodine-content salt water. It was directly coupled to an uncoated pipe.

The coated pipe (right) suffered no measurable damage. The uncoated pipe (left) corroded as deeply as a quarter of an inch — two-thirds of the way through the pipe.

Preserving metal and slashing maintenance costs, coatings based on VINYLITE Resins are widely used today in the petroleum, chemical, and processing industries...because they resist water, salt air, industrial atmospheres, oils, greases, alkalies, most strong acids, sunlight, heat, cold. Odorless, tasteless, non-flammable, they protect containers from contents, contents from containers.

We'll gladly send you a list of suppliers of metal, concrete and masonry coatings based on VINYLITE Resins. Write Dept. KX-68.

Coatings illustrated applied by Liquid Plastics Co., 640 N. Broad Ave., Wilmington, California and produced by Plastic Coating Corp., Houston 19, Texas, and 30 Rockefeller Plaza, New York 20, N.Y.

Vinylite
BRAND
RESINS

TRADE MARK

BAKELITE COMPANY
A Division of
Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, N.Y.

3 Good Questions...

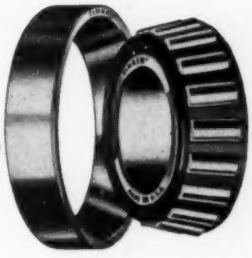
Why do TIMKEN® bearings take heavier loads and have longer life?

Why do TIMKEN bearings resist wear and retain precision longer?

Why are TIMKEN bearings more uniform in their high quality?

One Good Answer—

THE TIMKEN COMPANY MAKES ITS OWN STEEL!



THERE are several good answers to the questions above. But one of the *basic* reasons for the superior load capacity, wear resistance, and uniform high quality of Timken® bearings is the fact that the Timken Company makes its own steel. And the Timken Company is the only bearing manufacturer in America that does!

Having its own steel-making facilities enables the Timken Company to carry on research and development in steels that results in constant improvement in quality. It also permits complete control of the product—from melting through final inspection.

The high quality of Timken steel begins in the melting of selected scrap. Correct chemical composition of every heat is insured by use of the direct-reading spectrometer, new scientific instrument for analyzing a heat of steel in a matter of seconds. Even after the steel is in billet form, quality safeguards continue. The billets are scarfed and chipped to prevent cracks and flaws in the internal structure of the finished product.

Along with advanced design, precision manufacture, and rigid quality control, Timken steel is one of the big reasons why it pays to always look for the trade-mark "Timken" on the tapered roller bearings you buy. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ont. Cable address: "TIMROSCO".

TIMKEN *TAPERED ROLLER BEARINGS*

TRADE-MARK REG. U. S. PAT. OFF.

NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ↓ AND THRUST →◫← LOADS OR ANY COMBINATION →✳←

WHAT COULD BE MORE ECONOMICAL?

than a Scotchman at a free lunch OR a casing head that returns part of its original cost by saving valuable rig time

O-C-T "C-19" CASING HEADS HAVE SET A NEW *SAFETY STANDARD* for RIGS AND CREWS

Oil Center Tool Co.

P. O. Box 3091, Houston, Texas

Canada — Canadian Vickers, Montreal, Canada

Brazil — Argentina — La Grand, Sutcliff & Gell, Ltd., Southport, Lancashire, England. Address Export Inquiries for All Other Countries to P. O. Box 3091, Houston 1, Texas

Designed for quick setting and positive sealing, the O-C-T "C-19" Casing Head actually saves more than enough costly rig time to offset the slight additional first cost of this heavy-duty well control equipment. Besides, the O-C-T "C-19" gives PRICELESS PREMIUM PROTECTION against blowouts because the well is closed in around the casing and the seal applied automatically before blowout preventers are unflanged. Thus, elevators are released to raise blowout preventers. What could be more economical? So, don't be "penny wise and pounds foolish" by throwing away your blowout protection at the last minute FOR A MATTER OF HOURS for the chance to save a few dollars in initial well head costs! Ask your O-C-T Representative or write for details on the "C-19" . . . the only deep well head that has been used on both the world's highest pressure AND the world's deepest wells.

OLD . . . Bitumastic Enamel being applied by the "Sling Method."

NEW . . . Bitumastic Enamel being machine-applied.

PIPE-LINE PROTECTION

IS *better than ever* WITH BITUMASTIC!

● BITUMASTIC has a remarkable history of corrosion-prevention, dating back nearly 100 years. And 50 years ago, Bitumastic Enamel "came into its own" for pipe-line protection.

But years ago it wasn't easy to apply protective coatings. For example, the "Sling Method" shown in the photograph on the left was used by many pipeliners. One man poured the hot enamel into the sling; two men "see-sawed" the sling up and down. Naturally this manual method was slow and laborious.

It's a different story today. Pipe lines are cleaned, primed, coated and wrapped mechanically. The coating machine, shown in the photograph on the right, applies Bitumastic quickly and evenly. Bitumastic is a better product, too. Improved formulation makes it easier to handle and apply.

Today, thousands of miles of the world's oil and gas pipe lines are effectively protected against corrosion by Bitumastic Enamel. Get the *same* effective protection by specifying Koppers Bitumastic Enamel for your next pipe-line project.

Why Bitumastic Enamels give lasting protection

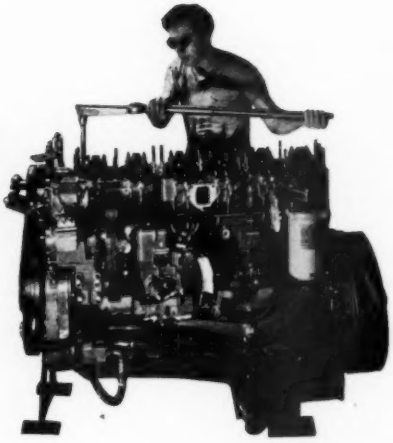
Processed from a base of coal-tar pitch, they are impervious to moisture . . . chemically resistant to soil elements. They make a tight bond with the pipe . . . do not disintegrate with age . . . maintain continuously high electrical resistance.

KOPPERS BITUMASTIC ENAMELS

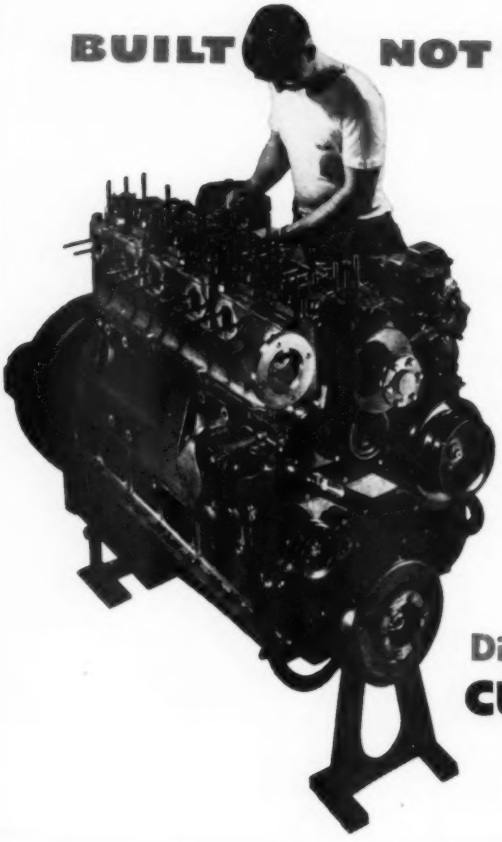
REG. U.S. PAT. OFF.

KOPPERS COMPANY, INC., Tar Products Division, Dept. 703-T, Pittsburgh 19, Pa.

Cummins®
CUSTOM BUILT
Diesels



BUILT NOT ONCE BUT TWICE



Each rugged, lightweight *and* high-speed Cummins Diesel is actually built *twice*. It's assembled, run-in tested, disassembled . . . inspected . . . then reassembled and tested again. And each engine is custom-built *to fit the job*. *Extra* care in building, Cummins exclusive fuel system, efficient service and parts organization, enable users to get *less* "down-time", *more* power and profits from Cummins Diesels. *See your Cummins Dealer.*

Diesel power by CUMMINS

CUMMINS Dependable DIESEL

Lightweight High-speed Diesel Engines (50-550 hp)
for: on-highway trucks
off-highway trucks • buses
tractors • earthmovers
shovels • cranes
industrial locomotives
air compressors
logging yarders and loaders
drilling rigs
centrifugal pumps
generator sets and power units
work boats and pleasure craft

CUMMINS ENGINE COMPANY, INC., COLUMBUS, INDIANA

Export: CUMMINS DIESEL EXPORT CORPORATION • Columbus, Indiana, U.S.A. • Cable: CUMDIEX

1 REFINE IT with Self-Propelled Cranes

At the refinery, a Lorain Self-Propelled Crane is ideal for loading and unloading materials, construction and erection jobs plus any other material handling duty. It has 4 speeds up to 7 m.p.h., is air steered and available in several types and sizes.

3 PROVED LORAIN TYPES to fit your BIG 3 jobs

Producers, refiners and pipe-liners, *the world over*, have used and proved Lorains on their roughest, toughest work. For your lifting, shifting, lowering jobs—for digging, rigging or erecting — for moving materials or equipment — there are proved Lorain types to fit your needs. See your Lorain Distributor for the interesting details.

THE THEW SHOVEL CO., LORAIN, OHIO

THEW **Lorain**

2 FIND IT with MOTO-CRANES

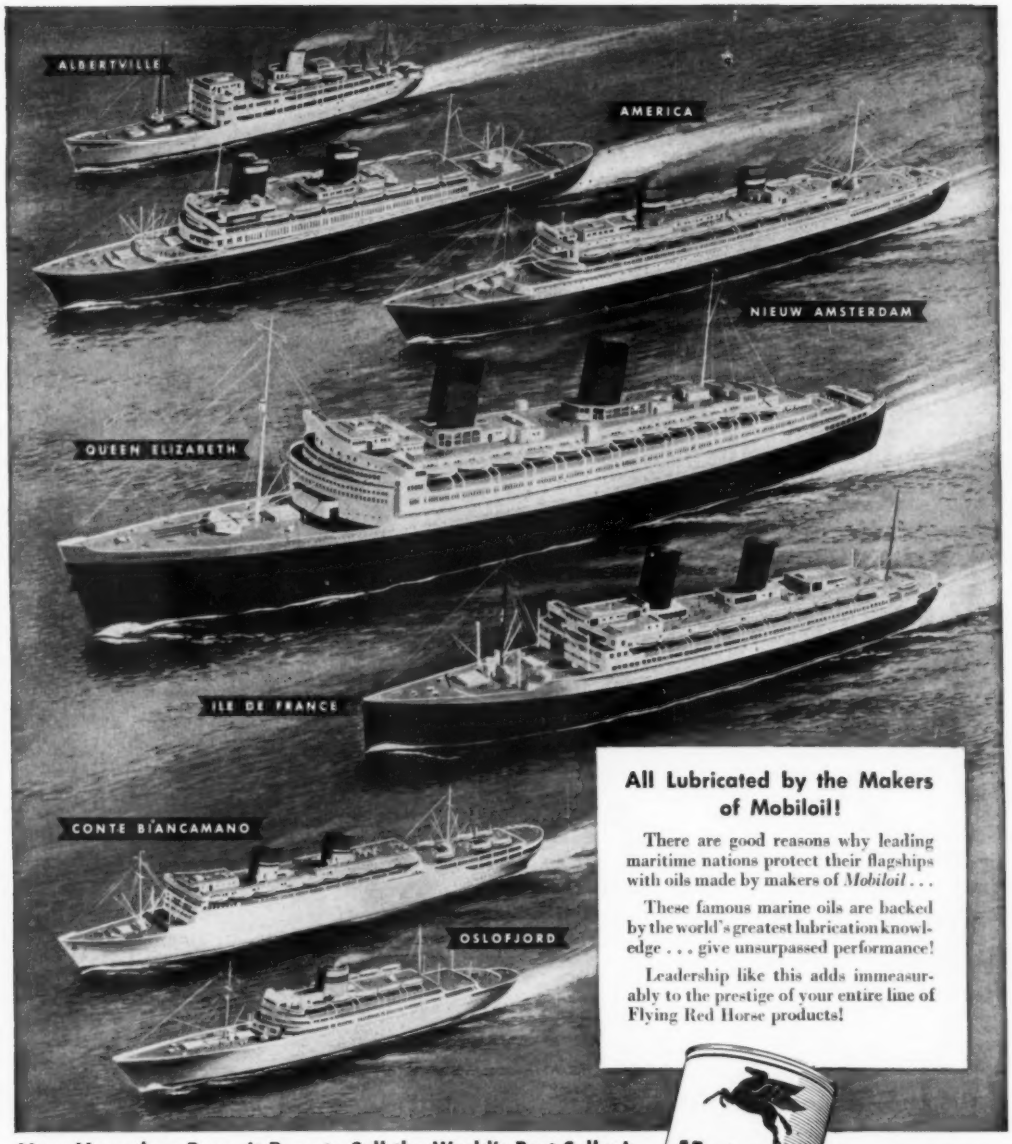
In the field, Lorain Moto-Cranes go anywhere the job demands — with speeds up to 30 m.p.h. plus big-tire flotation and tractive effort to travel off-road in rough or soft terrain. Here, two 20-ton Lorain Moto-Cranes are loading a 22-ton draw works — one of their many duties in more than 13,000 miles they already have traveled in the California oil fields.

3 TRANSPORT IT with "PIPELINERS"

Lorain "Pipeliners" — Junior (¾ yd.) and Senior (1 yd.) models — with extra-wide crawlers, straddle ditches safely as they dig. As clamshells or draglines, they dig river crossings and other wet jobs — as cranes they string and lay pipe, place valves. And rubber-tire Lorains speed over highways, or on the right-of-way from job to job.

Request your copy of the attractive, illustrated booklet, "Lorains in the Petroleum Industry". No obligation, of course.

First With the Flagships



All Lubricated by the Makers of Mobiloil!

There are good reasons why leading maritime nations protect their flagships with oils made by makers of *Mobiloil* . . .

These famous marine oils are backed by the world's greatest lubrication knowledge . . . give unsurpassed performance!

Leadership like this adds immeasurably to the prestige of your entire line of Flying Red Horse products!

Now More than Ever—it Pays to Sell the World's Best Seller!

Mobiloil

Mobilgas
SOCONY-VACUUM

SOCONY-VACUUM OIL CO., INC., and Affiliates: MAGNOLIA PETROLEUM CO., GENERAL PETROLEUM CORP.

Choose more than a truck-choose ability to haul on or off the road-Safely

"That big FWD is sure a 'bear' for work — on or off the road. Power to spare — handles like a kitten under any load."

"I'm convinced an FWD 6x6 is tailor-made for our kind of job — heavy hauling, bulky awkward loads — tough cross-country traveling."

That's typical oil-man talk about FWD's. The reasons for it are simple. There's added traction and safety with 6x6 drive and balanced distribution of weight and power — specifically engineered for smooth and rough going on hard surface or soft bottom. They all add up to one thing — continuous outstanding performance over longer truck life. Get the complete FWD 6x6 story — 30,000 lbs. to 60,000 lbs. GVW — an oil-man's truck for oil-man's work.

THE FOUR WHEEL DRIVE AUTO CO., Clintonville, Wis. • Canadian Factory — Kitchener, Ontario

World-Wide Sales and Service

America's Foremost Heavy-Duty Truck

GLOBE

GLOBE TUBES

***Specialization* Gives You Uniform High Quality In**

STAINLESS STEEL TUBES

GLOBE *Seamless*

GLOWELD *Welded*

- **Ease of Fabrication**
- **Resistance to Corrosion and Oxidation**
- **Strength at High Temperatures**

Globe engineers gladly give you the benefit of specialized knowledge of stainless steel tubing in a wide range of services and applications — to improve your product — to cut costs.

GLOBE produces 26 standard analyses of stainless steel tubes —also special analyses when required.

Globe seamless stainless steel tubing may be had in sizes from ⅛ inch to 6⅝ inches O. D., and in pipe sizes ⅛ inch to 6 inches, standard, extra strong and double extra strong weights.

Gloweld electric welded stainless steel tubing may be had in sizes ranging from ¼ inch to 5 inches O. D. inclusive; in standard weight pipe (schedule 40) sizes ⅛ inch to 2 inches—lightweight pipe (schedule 5 and 10) ⅛ to 4½ inches inclusive.

Globe Steel Tubes Co., Milwaukee 46, Wisconsin

Chicago • Cleveland • Detroit • New York • Philadelphia • St. Louis
Houston • Denver • San Francisco • Glendale, Cal.

TYPICAL ANALYSES

301, 302, 302B, 304, 308, 309, 309S, 309Cb, 310, 314, 316, 316Cb, 317, 321, 329, 330, 347, 403, 405, 410, 416, 430, 443, 446
Inconel* Nichrome**

* *Registered U. S. Trade-Mark.*
** *Trade-Mark Reg. U. S. Pat. Off.-D-H Co.*

Write for bulletin 333 — Corrosion and Heat Resisting Steel Analyses Chart — a valuable reference tabulation of stainless steel analyses as produced by various manufacturers.

Producers of Globe seamless stainless steel tubes — Gloweld welded stainless steel tubes — carbon — seamless steel tubes — Globeiron seamless high purity ingot iron tubes — Globe Welding Fittings.

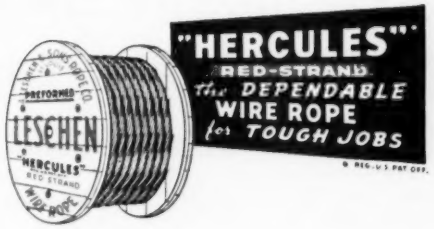
There Is More To Wire Rope Than Meets The Eye—

it's the invisible "ingredients" that make the difference.

Other than its one Red-Strand, a "HERCULES" Wire Rope would look pretty much like any other rope having no distinguishing mark. But there is a difference! And that difference is due to a "thousand and one" *invisible* factors. It is made possible by setting up and rigidly maintaining exacting standards . . . by utilizing our almost 100 years of manufacturing experience in the designing and fabrication of wire rope . . . by strictly following the principle of "quality first!"

As it has never been possible to actually see the numerous properties that make one wire rope outlast another, we originated—in 1886—the idea of painting one strand of "HERCULES" Wire Rope red, and since that time the Red-Strand has not only been a mark by which this rope could be identified, it has been our constant guarantee that its high quality is ever maintained.

Yes, there is more to "HERCULES" Wire Rope than meets the eye, but you can accept, with confidence, the assurance that the Red-Strand provides.



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How do you "stretch" a North American Tank car?

North American strives to keep its tank cars in good mechanical shape for fast, safe movement of petroleum products. This policy helps us obtain maximum availability from our cars, helps us to meet the tremendous demand for tank cars these busy days. By "stretching" tank cars wherever possible, we're doing everything we can to enable more shippers to move more petroleum—and faster.

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Remember—

the trade marks "tt" and "TUBE-TURN" are applicable only to products of TUBE TURNS, INC.

In special alloy piping systems, alloy TUBE-TURN *Welding Lap Joint Stub Ends permit use of lower-cost carbon-steel flanges as shown in cut-away view.*

Special alloys lick special piping problems

Write Dept. J-7 for free booklet "Pipe and Fitting Materials" which gives specifications, properties and welding procedures for various materials.

YOU can overcome special problems of corrosion, fluid contamination, pressure, or temperature by selecting pipe and welding fittings of special materials.

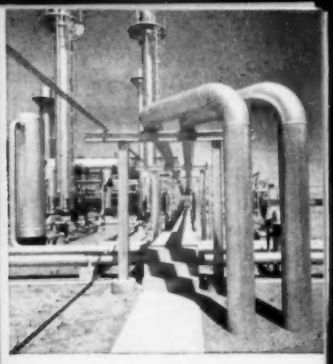
Tube Turns, Inc. continually studies the proper application of different materials to piping systems. The complete line of TUBE-TURN Welding Fittings is available in more than forty different alloys. Today's piping engineer can choose from intermediate and high alloy steels containing chromium, nickel, or both; commercially pure nickel, copper, and aluminum; and alloys of these.

Get in touch with your nearby Tube Turns' Distributor. You'll find one in every principal city.

"Be sure you see the double tt*"*

TUBE TURNS, INC. LOUISVILLE 1, KENTUCKY

DISTRICT OFFICES: New York • Philadelphia • Pittsburgh • Chicago • Houston • Tulsa • San Francisco • Los Angeles
TUBE TURNS OF CANADA LIMITED, CHATHAM, ONTARIO... A wholly owned subsidiary of TUBE TURNS, INC.



Simple or complex, directional changes are accomplished smoothly and easily with TUBE-TURN Welding Fittings. Pressure loss is reduced, joints are permanently leakproof.

Welded piping–backbone of progress

In 1950, refinery operations in the U. S. reached an all-time high. *Crude runs to stills averaged nearly 5¾ million barrels per day.* More than 6 million barrels per day is the predicted average for 1951!

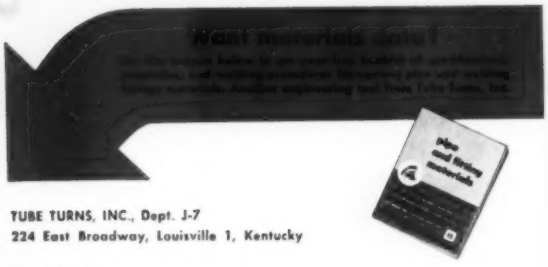
Production like this demands an incredible amount of piping and enormous quantities of welding fittings and flanges. In an industry where severe service conditions are the rule, welded piping and strong, safe, permanently leakproof joints are indispensable.

That's why you'll find TUBE-TURN Welding Fittings and Flanges in the piping systems of virtually every major refinery in the country. Ever since seamless welding fittings were introduced by Tube Turns, Inc., they have solved many piping problems for the petroleum industry. Carefully engineered to provide the utmost in strength, safety, and endurance, they have played a significant role in its development and progress.

As refining operations become more and more complex, piping needs become increasingly diverse. Tube Turns, Inc. will continue to keep pace. Today, and in the future, the petroleum industry can look to Tube Turns, Inc. not only for the most extensive line of welding fittings and flanges, but for valuable and authoritative help in the field of piping engineering. See your authorized Tube Turns' Distributor now.

Forged-in strength of TUBE-TURN Welding Fittings defies high pressures. Piping design is greatly simplified, maintenance problems are eliminated.

Piping systems can be fabricated quickly and economically with TUBE-TURN Welding Elbows. True circularity, uniform wall thickness insure accurate fit, even with odd angles.



TUBE TURNS, INC., Dept. J-7
224 East Broadway, Louisville 1, Kentucky

Your Name .....

Position .....

Company .....

Nature of Business .....

Address .....

City ..... *State* .....

TUBE TURNS, INC.

LOUISVILLE 1, KENTUCKY

DISTRICT OFFICES

New York	Houston
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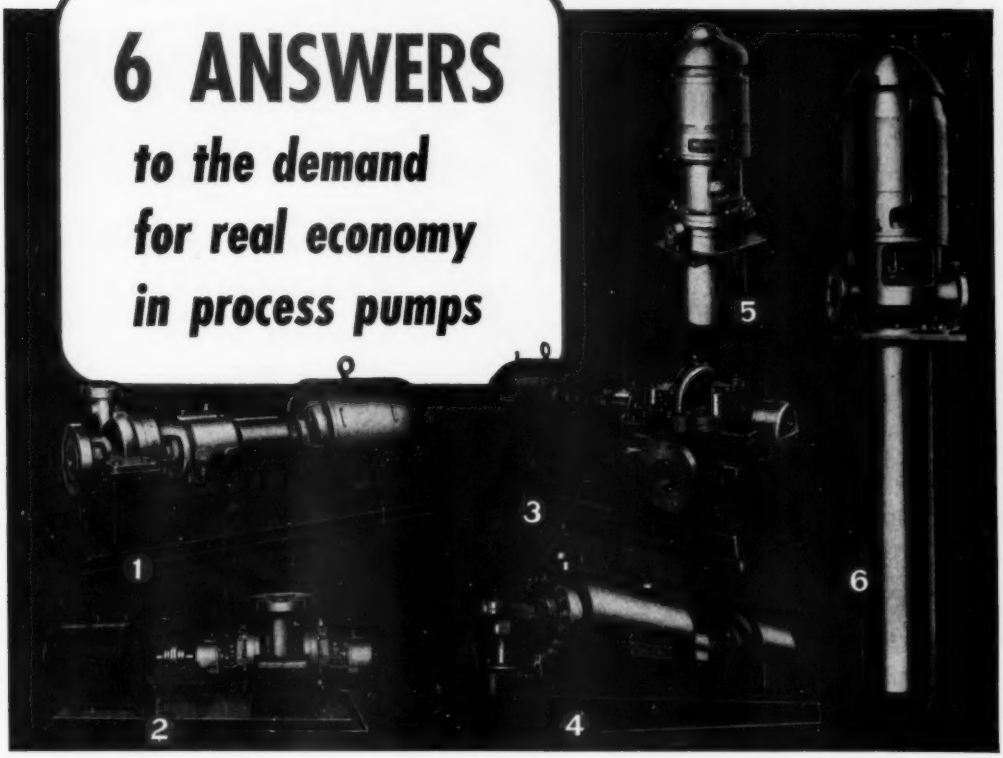
"tt" and "TUBE-TURN" Reg. U.S. Pat. Off.

6 ANSWERS

to the demand for real economy in process pumps



These six types of Ingersoll-Rand process pumps offer you important savings in most refinery jobs.

For most refinery and process plant applications, there's an Ingersoll-Rand pump that is right for the job. This means more than just meeting design conditions – it means construction of the *right* materials and the *right* sealing arrangement, with either the Cameron Shaft Seal or an adaptation of a packed stuffing box. These and other points of pump know-how can only be gained through years of field and design experience – experience which Ingersoll-Rand has had in over 50 years of service to the petroleum industry.

Let your nearest I-R representative give you the details on the real economy of I-R pumps – high sustained efficiency, economical operation, and low maintenance.

	PUMP TYPE	STAGES	CAPACITIES	HEAD
1	Vertically split with top (or bottom) suction and discharge or end suction and top discharge	Single stage	20 to 3200 gpm	Heads to 600 feet
2	Vertically split with top suction and discharge	Single stage	250 to 3500 gpm	Heads to 1100 feet
		Two stage	200 to 1200 gpm	Heads to 1100 feet
3	Horizontally split with side suction and discharge	Single stage	30 to 2300 gpm	Heads to 750 feet
		Two stage	170 to 1300 gpm	Heads to 1100 feet
4	Diffusor type with "double-case" construction. Top suction and discharge.	Multi stage	450 to 3000 gpm	Heads to 6000 feet
5	Vertical pump, diffusor type	Multi stage	20 to 400 gpm	Heads to 4800 feet
6	Vertical pump, turbine type	One or more stages	60 to 35,000 gpm	Heads to 150 feet per stage

Compressors • Air Tools • Rock Drills
Turbo Blowers • Condensers • Centrifugal Pumps
Diesel and Gas Engines

Ingersoll-Rand

11 Broadway, New York 4, N. Y.

589-10

LUNKENHEIMER

Shoulder-Less Steel Valve Seat Rings . . .

- CAN'T WEDGE OUT OF PLACE
- SEAT TIGHTER WITH SERVICE
- ASSURE GREATER BODY STRENGTH
- WILL NOT WARP
- EASILY RENEWABLE

Notice how the inner facing of the Lunkenheimer ring seats squarely against the body wall. There's no flange or shoulder where corrosion can work its way inside — no bending that causes leakage.

This end-seated Lunkenheimer ring *stays put* — won't warp out of place or twist away from the body as it is tightened. See how firmly the heavy ring seals itself into the wall, becoming an integral part of it, adding *extra* strength at the "nerve center," guarding against corrosion.

And this ring actually seats more tightly with years of wear.

Should you ever need to replace it — heavy lugs inside the ring make renewal simply a matter of screwing the old one out, the new one in . . . quickly, without serious production delays.

Before you approve that next order for steel valves in your plant, be sure to double-check seat ring construction. For longer life and lower maintenance costs, specify Lunkenheimer steel valves . . . with *shoulder-less* seat rings.

Write today for your copy of "Lunkenheimer Cast Steels," an informative 52-page brochure on the development and application of steel valve alloys. *The Lunkenheimer Co., Box 360-F, Cincinnati 14, Ohio.*

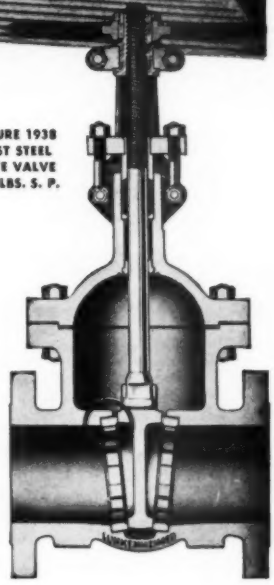


FIGURE 1938
CAST STEEL
GATE VALVE
300 LBS. S. P.

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LUNKENHEIMER

THE ONE *Great* NAME IN VALVES

C-451-B

A ONE MAN "FIRE ENGINE"

—the Kidde Dry Chemical Wheeled Extinguisher

You *can* control a roaring fire in inflammable liquids, live electrical equipment, textiles or L-P gas. The Kidde 150 Pound Dry Chemical Wheeled Extinguisher packs a fire-fighting wallop that brings large fires under control quickly and easily.

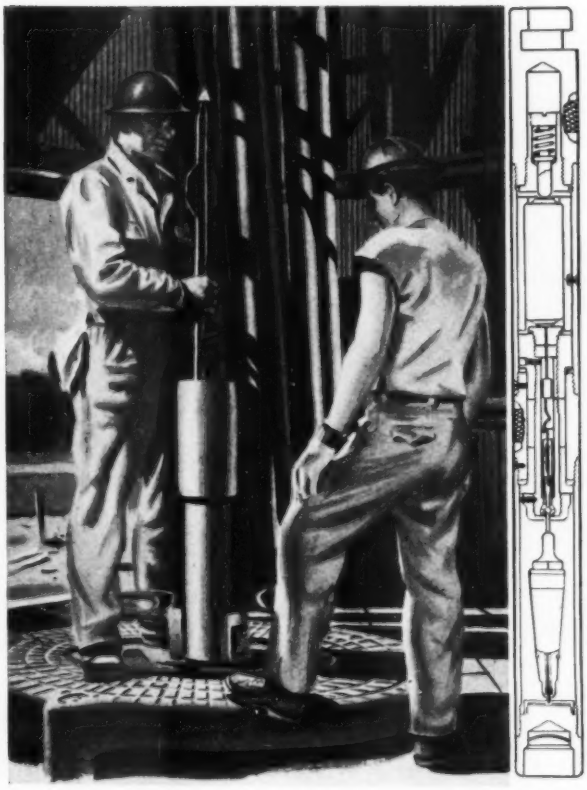
The new "instant flow" hand control enables you to beat back fire with a long range "straight" stream... or to blanket the fire completely by the wider coverage which you get from the improved "fan" pattern.

One man can wheel this extinguisher through a standard doorway... apply 150 pounds of fire-smothering dry chemical in less than one minute.

Write for complete information on this new Kidde Dry Chemical Wheeled Extinguisher . . . or the full line of Kidde fire extinguishers and built-in systems.

Kidde

Walter Kidde & Company, Inc., 754 Main Street, Belleville 9, N. J.
Walter Kidde & Company of Canada, Ltd., Montreal, P. Q.



SERVICE SPEED ACCURACY

Yours with the E-C Inclinometer

SPERRY-SUN SERVICE on its instruments means they are serviceable when you are ready to use them.

The E-C Inclinometer records *automatically* and *immediately* after coming to rest. It can be go-deviled or lowered into the hole on a line by any conventional method in either rotary or cable tool operation.

The record is made by small electrical current which makes a dot on the recording disc only when the E-C is at rest. To double-check with an E-C, just raise it a few feet and again lower it to the previous depth. In this way you check for movement of the instrument and alignment of the axis of the instrument with the axis of the drill collar. Your reading's accuracy is then checked and double-checked.

Write for your copy of our reprint from the 18th edition of the Composite Catalog for details on all of our services and instruments.

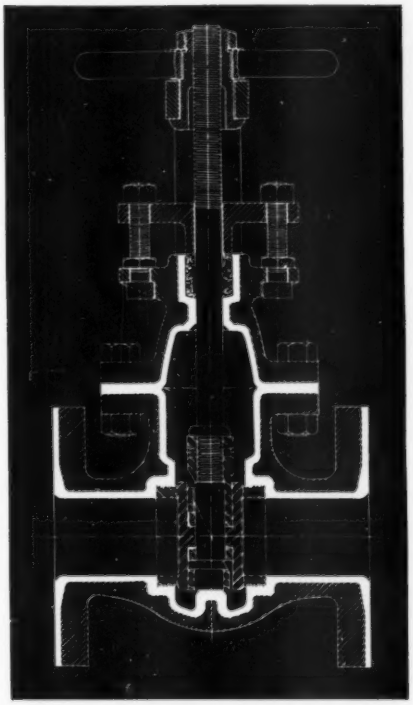
SPERRY-SUN WELL SURVEYING COMPANY

3118 BLODGETT AVENUE HOUSTON, TEXAS

Philadelphia, Pa. Fellurrias, Odessa, Marshall, Texas Long Beach, Ventura, Bakersfield, Calif.
Oklahoma City, Okla. Lafayette, La. Mouldon Oil Field Services, Casper, Wyo. Crossville, Illinois

HANDLING CORROSIVE FLUIDS?

this unique hard rubber lined iron body gate valve offers big savings in many corrosive services . . .



Darling 150-pound rubber lined gate valve, with outside screw and yoke, featuring unique parallel seat, fully revolving disc principle. Plain "no pocket" discs prevent accumulation of sediment. Darling rubber lined gate valves can be furnished only in rising stem, cylinder or motor operated; or quick-opening types.

WHEN Darling gate valves of this type go to work, you gain *multiple* advantages sure to save you money *and* time.

First, you gain big initial savings because these rubber lined iron body gate valves (ideal for many corrosive services not exceeding 180° F.) are much less expensive than special alloy valves. Moreover, Darling's special bonding technique permanently prevents separation of the hard rubber lining from the valve body.

All interior working parts are made of alloys suitable for the corrosive conditions encountered.

Secondly, and equally attractive, is Darling's exclusive *fully revolving double disc, parallel seat* feature! In a nutshell this means drop-tight closure where most other valves would fail. It also assures unmatched life with a very minimum of attention and maintenance.

Here's a combination you just can't beat! Before you buy gate valves of *any* type, get acquainted with these unique Darling valves and their operating details. Get *all* the facts.

Write today for free bulletin describing Darling rubber lined gate and check valves.

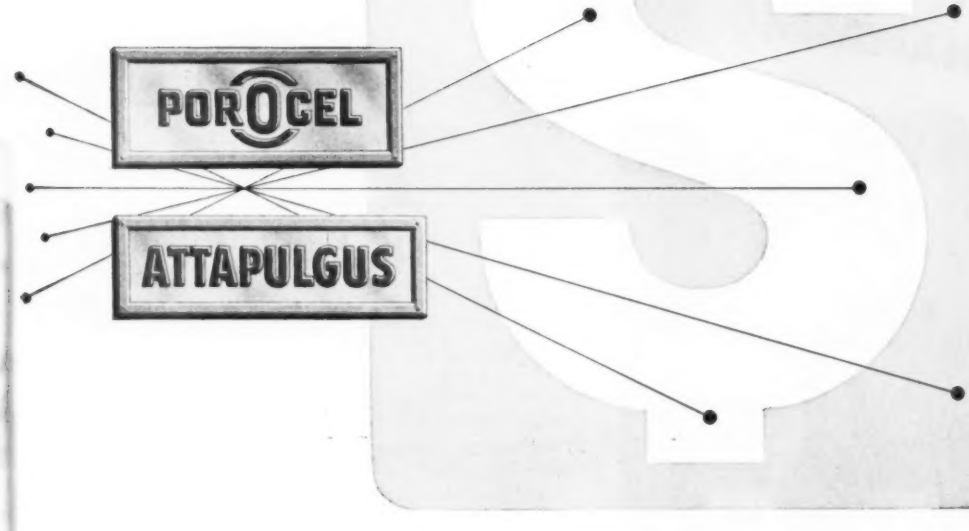
DARLING VALVE & Manufacturing Co.
WILLIAMSPORT 1, PA.

DARLING VALVES FOR EVERY NEED

Darling parallel seat revolving disc gate valves are available in a wide range of sizes and constructions for all kinds of normal and unusual service, and for pressures up to 1500 pounds. In addition to rubber lined, iron body valves, corrosion resistant types include plain iron body with special alloy trim, cast steel, all bronze, special alloys or combinations as required. We'll gladly furnish specific recommendations on the proper valves for your particular service.

FOR PLUS VALUES, JOB-PROVED AGAIN AND AGAIN

SMALL CAUSE... BIG EFFECT



Here's an interesting case of small cause—big effect! "Small cause" is the inexpensiveness of Attapulgus Fullers Earths and Porocel Activated Bauxites. "Big effect" is the large number and intrinsic value of jobs these materials do for petroleum refiners.

From the lightest hydrocarbons down to the heaviest lube and wax fractions, many of the finished products have received treatment by these sorptive minerals somewhere along the line. Odors, colors, tastes, moisture, acids, sulfur, fluorides and unsaturates are removed or converted; various reactions are catalyzed.

Most important, all these applications pay off. Attapulgus and Porocel adsorbents cost as little as one cent a pound. But each pound, properly applied to petroleum stocks, increases the value of these stocks by at least one dollar—a return of 100 to 1.

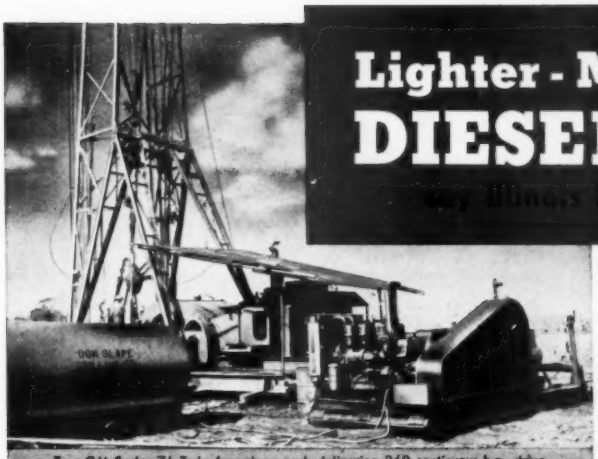
So let's get together on your plans to improve quality, expand output, or both. You know a lot about the techniques involved in these processes; our engineers have made many important contributions to adsorbent technology. A blending of these two funds of knowledge should produce optimum results.

ATTAPULGUS CLAY COMPANY *Fullers Earth* • **POROCEL CORPORATION** *Activated Bauxites*

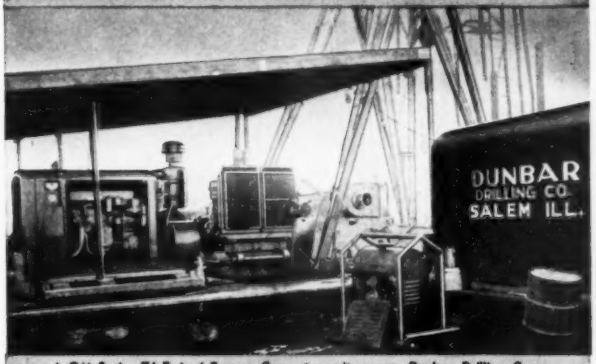
Dept. V, 210 West Washington Square, Philadelphia 5, Pa.

Lighter - More Compact
DIESEL POWER

say Illinois Drilling Contractors



Two GM Series 71 Twin 6 engines, each delivering 260 continuous h.p., drive Don Slape Drilling Company's "Oil Well" 648 drawworks and 712-P mud pump.



A GM Series 71 Twin 4 Torque Converter unit powers Dunbar Drilling Company's Cardwell Model "L" drawworks; their National C-150 mud pump is pulled by a new GM 6-110 Diesel, delivering 186 continuous h.p.

Don Slape of Don Slape Drilling Co., Olney, Ill., bought his first GM Diesels four years ago. He says: "We found your engine was more compact and lighter than any engine we had used in our 20 years' experience in the oil fields. *They're easier to move, which is a big advantage.*" Mr. Slape, who owns 16 GM Diesels, reports his newest engines are even better than the first.

Joe Dunbar of Dunbar Drilling Co., Salem, Ill., gives this report on his new GM 6-110 Diesel: "The 6-110 is more economical to operate and is doing the job faster than former engines. Light weight and compactness are additional factors in favor of the 6-110. One of the best things about this rig is that it's underweight and underwidth and *you don't need a permit to move it.*" Mr. Dunbar who also owns several other GM Diesel engines, was the first to use the new 6-110 Diesel in an oil field application.

● **DRILLING CONTRACTORS** everywhere are saying "Lighter—more compact." And these are just two of the features that make GM Diesel engines first choice in the oil fields. For more power in less space—for easier moves and quicker setups—for faster drilling at lower cost, be sure to investigate GM Diesel engines. Contact your nearest distributor or write us direct.

ANSWER THE CALL CIVIL DEFENSE

DETROIT DIESEL ENGINE DIVISION

SINGLE ENGINES...Up to 275 H.P. **DETROIT 28, MICHIGAN** MULTIPLE UNITS...Up to 800 H.P.

GENERAL MOTORS

GM GENERAL MOTORS DIESEL POWER

DIESEL BRAWN WITHOUT THE BULK

GENERAL MOTORS CORP., DIESEL ENGINE SALES, PETROLEUM INDUSTRY, 1504 Philtower Bldg., TULSA 3, OKLAHOMA

CALIFORNIA: Anderson-O'Brien Co., Los Angeles 21; Lawless Brothers, BAKERSFIELD; West Coast Engine & Equipt. Co., BERKELEY. **ILLINOIS:** Western Machinery & Engine Co., CENTRALIA. **KANSAS:** Diesel Equipment Co., Inc., WICHITA. **COLORADO:** Colorado Builders' Supply Co. (Equipt. Division), DENVER. **LOUISIANA:** George Engine Co., Inc., HARVEY; United Tool Company, SHREVEPORT. **MISSISSIPPI:** Taylor Machine Works, JACKSON. **MISSOURI:** Western Machinery & Engine Co., ST. LOUIS 10. **MONTANA:** Seitz Machinery Co., Inc., BILLINGS; Mountain Tractor Co., MISSOULA. **OKLAHOMA:** Diesel Power Co., OKLAHOMA CITY. **TEXAS:** Stewart & Stevenson Services, Inc., HOUSTON 1, McALLEN, DALLAS, CORPUS CHRISTI, WICHITA FALLS; Haynes Machinery Co., PLAINVIEW; Empire Machinery Co., Ltd., ODESSA. **WYOMING:** Colorado Builders' Supply Co. (Equipt. Division), CASPER.

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Published by
CRUTTI and ROCKWELL
Corporation

ENGINEERING News

Novel Portable Unit Conveys Spent Clay From Sun Plant

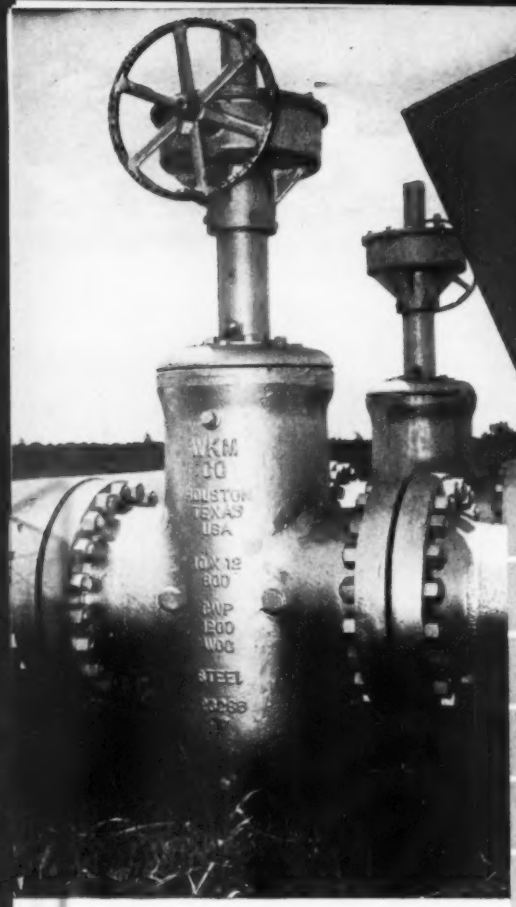
Sun Engineers Mount SK Hopper Eductor On Rolling Platform to Solve Handling Problem

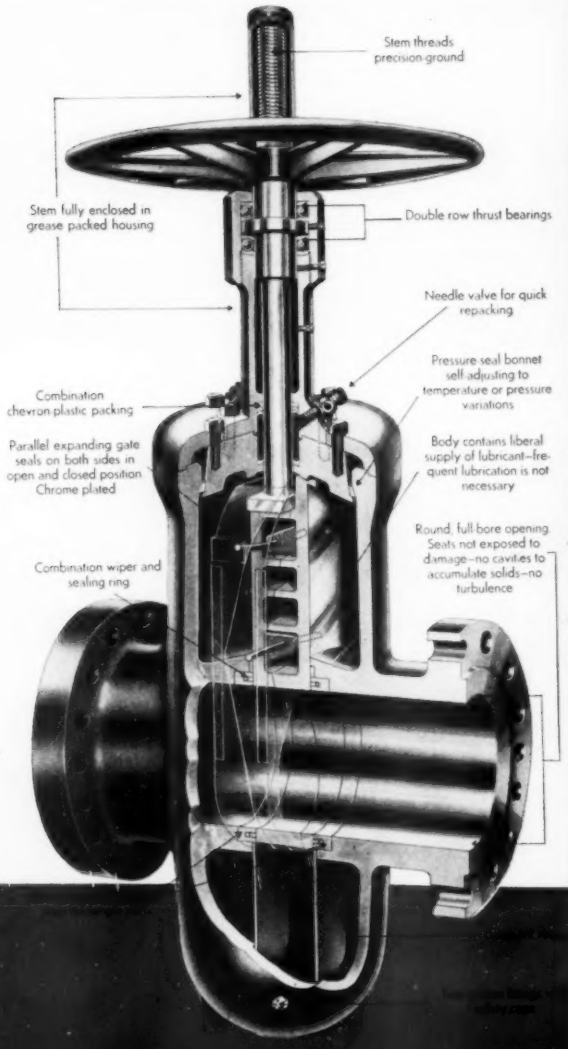
[Illustration and Story by Courtesy of Sun Oil Company]

WITH the arrangement shown in the photo, engineers at the Marcus Hook, Pa., Refinery of Sun Oil Company neatly solved a materials handling problem and materially decreased the time required to convey spent clay from several filter shells to a settling basin outside the building.

They mounted a standard SK Fig. 254 Hopper Type Eductor on a movable platform in such a way that the hopper is located above the platform and the eductor proper below. Flexible pressure and discharge hose connections are used.

PIPELINERS' PREFERENCE




Stem threads precision-ground
Stem fully enclosed in grease packed housing
Double row thrust bearings
Needle valve for quick repacking
Pressure seal bonnet self adjusting to temperature or pressure variations
Combination chevron plastic packing
Parallel expanding gate seals on both sides in open and closed position Chrome plated
Body contains liberal supply of lubricant—frequent lubrication is not necessary
Round, full bore opening. Seats not exposed to damage—no cavities to accumulate solids—no turbulence
Combination wiper and sealing ring

- **Round, full-bore opening reduces turbulence; does not restrict flow.**
- **Parallel, chrome-plated expanding gates provide positive shutoff without requiring frequent lubrication.**
- **Double-row thrust bearings assure ease of operation.**
- **Seats are not exposed to flow and there are no gate cavities to collect solids.**

Furnished in Series 300, 400, 600, 900 and 1500, W-K-M Pipe Line Valves are available for quick delivery in sizes from 2" through 30". Their exclusive and time-proved features provide safety, dependability and economy unequalled by any valve designed for similar services.

For the utmost in valve value, specify "W-K-M" for gas, oil or finished products lines and stations.

W-K-M Company

OIL FIELD, PIPE LINE & INDUSTRIAL EQUIPMENT

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ENGINEERING News

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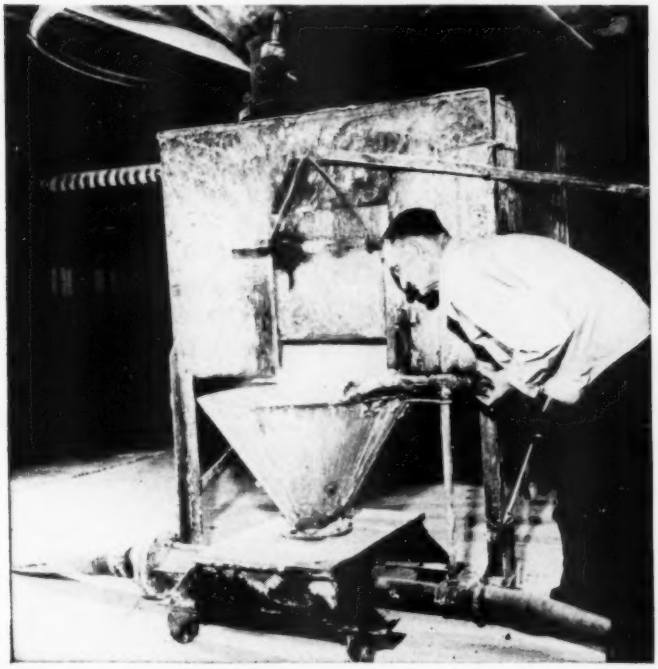

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They mounted a standard SK Fig. 254 Hopper Type Eductor on a movable platform in such a way that the hopper is located above the platform and the eductor proper below. Flexible pressure and discharge hose connections are used.

When it becomes necessary to remove spent clay from any one of ten filter shells, a movable secondary drum, or hopper, is rolled under the man-head of the filter shell and the spent clay is dropped into this. A manually operated gate in the secondary hopper is regulated to permit the proper amount of clay to feed into the eductor hopper.

Pressure water, by-passed from the inlet line on the eductor, issues through the secondary spray nozzles in the eductor hopper and washes the clay down into the eductor chamber. Pressure water, issuing through the nozzle of the eductor, entrains the clay and discharges through the flexible hose with sufficient force to carry the clay-water slurry to a settling basin outside the building.

This is but one of many ways a wide variety of standard eductors manufactured by SK have been applied by ingenious engineers in a variety of industries. *For facts and figures on all types of eductors and for ideas and suggestions concerning their use, request Bulletin 2-M.*

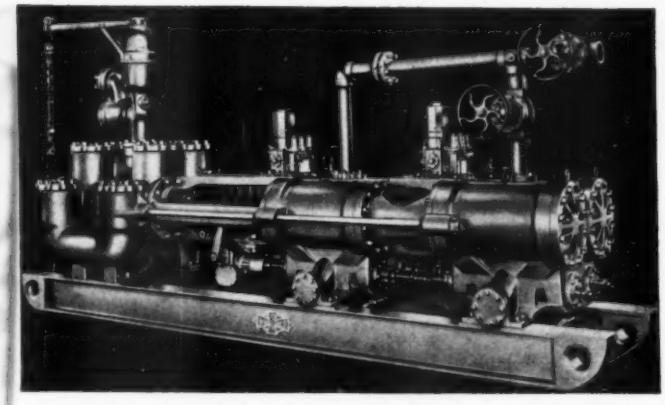
This photo shows the extent to which SK Rotameters are used in the plant of Publicker Industries, Inc., of Philadelphia, world's largest producers of industrial alcohol. All of the Rotameters shown on the panel are of the SK Universal type and are used to measure fluid flow rates in the manufacture of commercial alcohol. Numerous sizes are represented since capacity requirements vary considerably. Bulletin 18-RA pictures and briefly describes the numerous types of Rotameters manufactured by SK and lists the technical bulletins available. If interested, send for a copy.

SCHUTTE and KOERTING Company
Manufacturing Engineers

the WHELAND
QUAD STEAM PUMP

H-20000-BAB 16½″ x 16½″ x 20″ – 8″, 7½″, 7″

- **Eliminates compounding troubles**
- **Either one or both steam cylinders may be used as desired**
- **More economical than two separate pumps**
- **Equivalent to a two-cylinder duplex pump with cylinders 23 5/16″ bore**



- **Steam horsepower equivalent of two 16½″ x 20″ x 8″ pumps**
- **2,875 lb. mud pressure at 300 lb. steam with 8″ liners**
- **9.584 to 1 steam to water ratio with 8″ liners**
- **Liners need changing less frequently**
- **"Upside down" steam ends, patented**
- **Net weight only 32,800 lbs., with skids**

Here's a pump with all the "guts" for big steam rigs. The specifications below tell its story, and each day the units in operation demonstrate the efficiency and values of WHELAND H-20000-BAB QUAD PUMP.

H-20000-BAB WHELAND QUAD STEAM PUMP SPECIFICATIONS

Steam cylinders	16½″ and 16½″ x 20″
Hydrostatic test on steam cylinders	700 P.S.I.
Steam pressure, maximum working pressure	350 P.S.I.
Speed, normal R.P.M. each side	50
Steam pipe size to each cylinder	4″
Exhaust pipe size from each cylinder	4″
Main cylinder, Piston rod diameter	3¾″
Auxiliary cylinder, Piston rod diameter	3¼″
Water piston rod diameter	3⅛″
Water piston rod fitted for No. 6 A.P.I. piston	
Tie rods, diameter	2¼″

FLUID END

Material, solid one-piece steel casting	
Hydrostatic tested, discharge ports to	6000 P.S.I.
Hydrostatic tested, suction ports to	3000 P.S.I.
Maximum working pressure recommended	3000
Discharge pipe, standard size	4″
Suction pipe, standard size	10″

COMPLETE MECHANICAL DETAILS ON REQUEST

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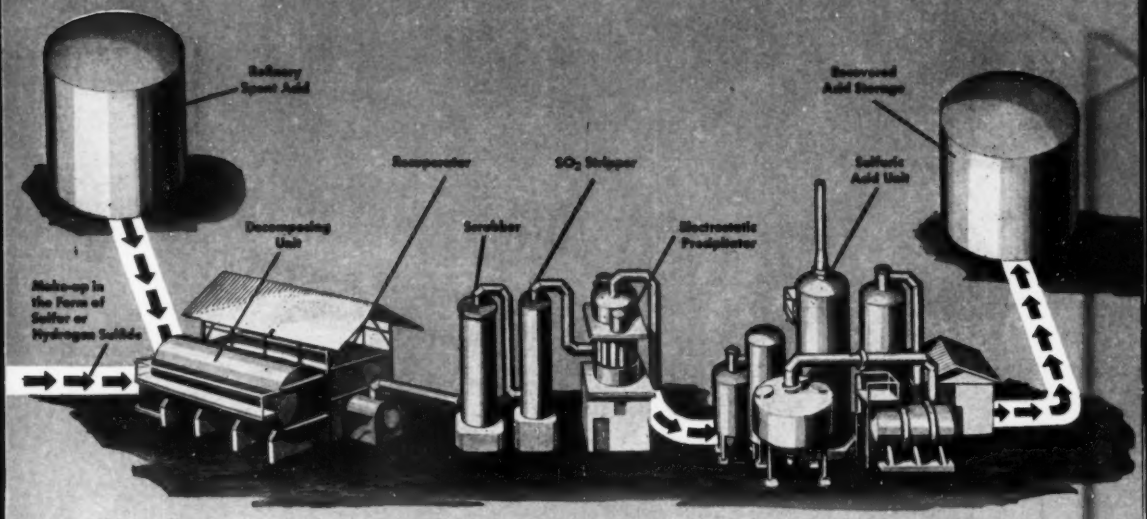
CHEMICO OFFERS AN ECONOMICAL PROCESS FOR

Spent Alkylation Acid Regeneration



*D*ue to the increased cost of brimstone and the vital need to conserve basic sulfur deposits, petroleum refiners producing high octane aviation gasoline will find it desirable to recover the sulfuric acid from their spent alkylation acid. For this purpose, Chemico offers a proven and economical process.

In this process, spent alkylation acid—now in greater supply as a result of the increased manufacture of high octane gasoline—is sprayed into a furnace maintained at a high heat with auxiliary burners. Sulfur or hydrogen sulfide may be used as fuel thereby producing SO_2 gas for the production of make-up acid.

A limited amount of other liquid acid sludges, high in hydrocarbon content, may also be added to the alkylation spent acid, thus providing fuel as well as additional acid production. The hydrocarbons are completely consumed and the acid is broken down into its components—sulfur dioxide, oxygen and water. After the water is removed, the gas is processed to fresh acid of 98% strength in a Chemico contact sulfuric acid unit. Send for additional information, stating your requirements.

CHEMICAL CONSTRUCTION CORPORATION

A UNIT OF AMERICAN CYANAMID COMPANY

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EUROPEAN TECHNICAL REPRESENTATIVE: CYANAMID PRODUCTS, LTD., LONDON W. C. 2, ENGLAND
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is a precision-made product in every respect. A sucker rod string is only as strong as its couplings. Make sure you use JONES.

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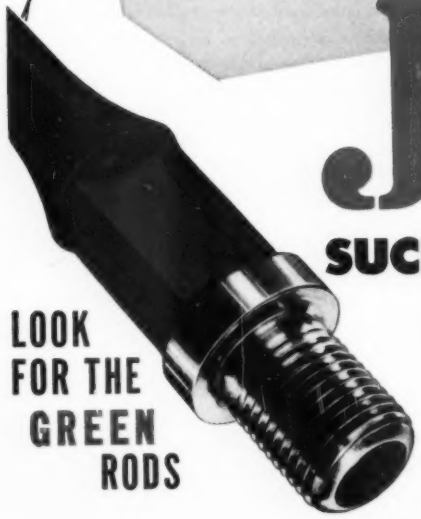
SUCKER ROD COUPLINGS

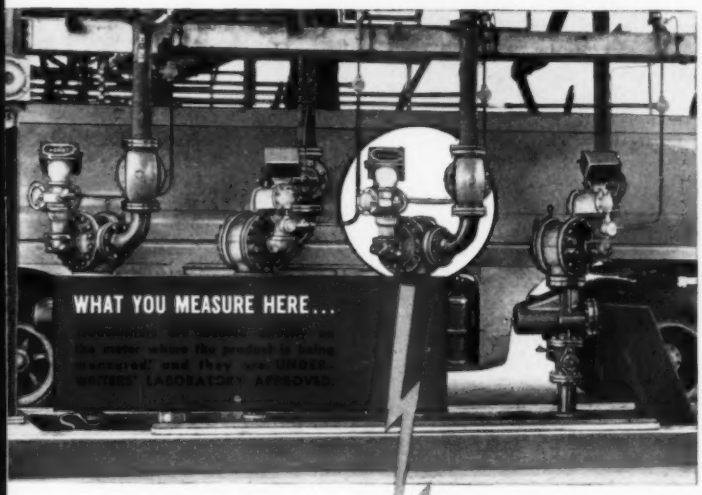
Best in the Field!



LOOK FOR THE GREEN RODS

THE S. M. JONES COMPANY
Division of Buffalo-Eclipse Corporation
General Office and Factory: Toledo, Ohio
Sales Office: Kennedy Building, Tulsa, Okla.
Export Sales Office: Buffalo International Corp.
50 Church Street, N. Y. C.

Remote Metering a Reality!

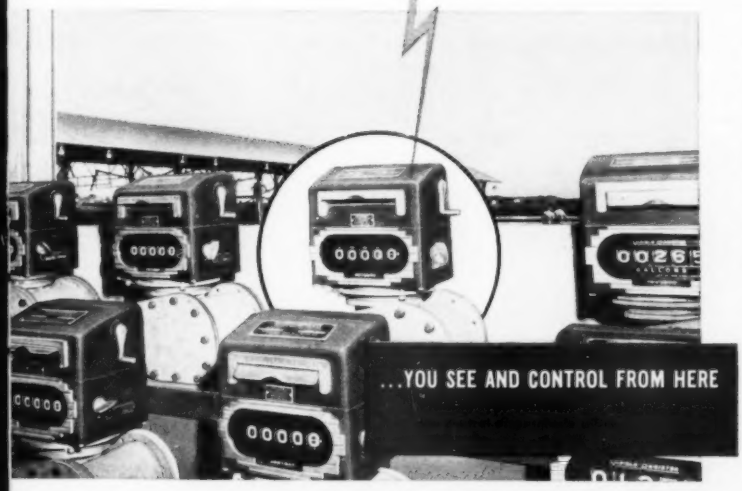


Have Positive Basic Accounting, Gain Security

THE ROCKWELL WAY at Bulk Plants, Pipe Line Terminals

You can get *exact* control over measurement when your Rotocycle meters are fitted with Rockwell Remote Registration Units. That's because this system transmits all meter readings to a central control room under the eyes of the plant supervisor. It's done safely, swiftly, surely by electrical impulses. Your dispatcher has complete control over every loading throughout the plant. And you get unalterable printed totals to verify each transaction. With the Rockwell system you reduce the human element of error to a minimum—gain greater plant security. These units are now available both for new metering installations as well as for application to existing Rotocycle meters. Write for bulletin OG-324.

It's done Electrically . . . with Safety and Surety



Remote reading is accomplished by electrical synchronous type motors, UL approved, with the motor fields of both the transmitter and receiver directly connected to a common 115 volt, 60 cycle A.C. power supply and their armature circuits interconnected. Through a gear drive the transmitter is rotated proportionately to the meter revolution as the product is being measured. With the field circuits energized the rotations of the transmitter are exactly duplicated by the receiver in the control room.

ROCKWELL

ROCKWELL MANUFACTURING COMPANY
PITTSBURGH 8, PA.

Atlanta Boston Chicago Columbus Houston Kansas City Los Angeles
New York Pittsburgh San Francisco Seattle Tulsa

Rockwell Remote Registration Units

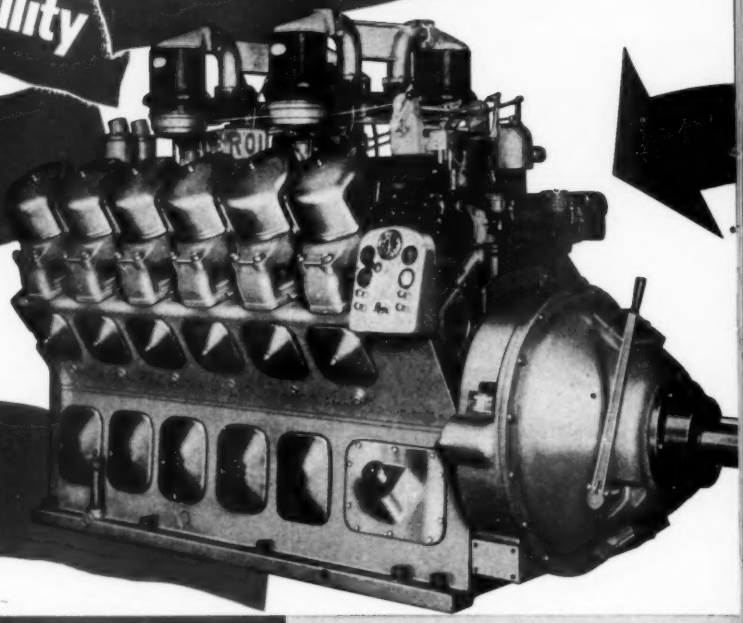
can also be applied to existing Rotocycle meter installations

Greater Accessibility

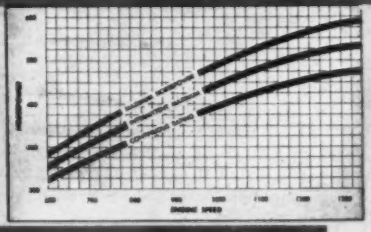
Greater Speed Range

Compactness

More Power

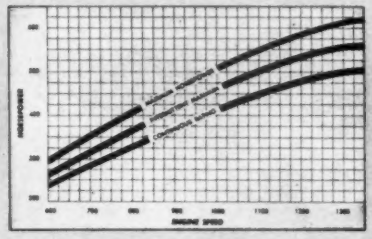


More Power—Wider Speed Range

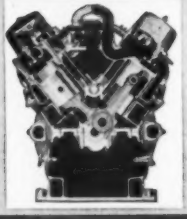


Gasoline or natural gas

Butane

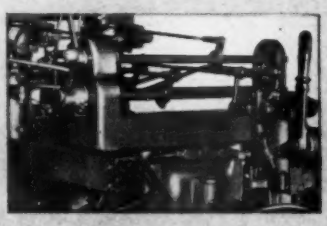


Faster Acceleration



Take a good look at the L-3460's V-12 design. Note the lightweight aluminum pistons, and short-radius rotating parts. You can see why the L-3460 gives you lightning-fast response to load demand.

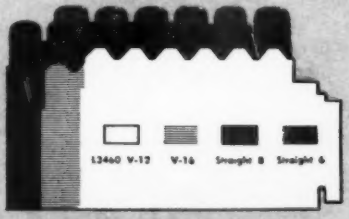
This governor will interest you, too. It is semi-hydraulic and responds instantly to load changes, whatever they may be.



More Compact—Easy Installation

LE ROI

Just compare the L-3460 with other designs of equal displacement. Remember too, the L-3460 complete with radiator, weighs only 12,200 lbs. That's why the L-3460 saves you installation time and money — is easier to move around.



LeRoi 600hp L-3460

EVERYTHING YOU ASKED FOR IN AN ENGINE

The L-3460, with its 600 maximum horsepower, is designed and built to meet oil-field demands for more power.

Its fast acceleration, wide speed range, lugging power at slow speeds, and compactness make it outstanding for drill-rig applications.

Its dependability and economy under continuous load, its space-saving size for easy installation, and its accessibility that simplifies maintenance give you an unbeatable power unit for any type of oil-field application — drilling, pipeline, generator drives, etc.

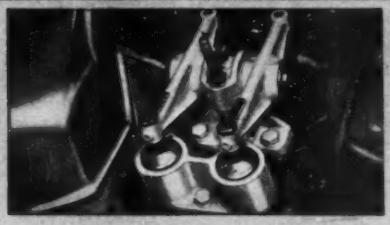
Here, in the L-3460, you have oil-field power at its best — wide speed range from 600 to 1350 rpm, and horsepowers from 350 to 600. If you want to keep a tight rein on costs, nothing but the best will do. So let the L-3460 go to work for you now — it's everything you asked for in an engine. For further information, see your Le Roi distributor — or write for our new bulletin E-3.

LE ROI COMPANY

MILWAUKEE 14, WISCONSIN

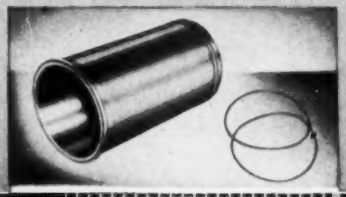
Plants: Milwaukee — Cleveland — Greenwich, Ohio • Oilfield Headquarters: Tulsa, Oklahoma

Easier Maintenance—Lower Costs



Valve-in-head design lets one man remove cylinder heads without disturbing manifold, carburetor, or controls.

One-piece crankcase and cylinder construction provides unusual rigidity — prevents misalignment. The L-3460 is built to take the punishment of oil-field handling.



Replaceable cylinder sleeves do away with costly reboring and expensive oversize parts.

P-109

LEADS THE FIELD

Le Roi Oilfield Sales

Oklahoma
Le Roi Company Branch — Tulsa
Carson Machine & Supply Co.— Oklahoma City

East & South Texas, Gulf Coast
Southern Engine and Pump Company — Houston, Kilgore, Edinburg, Dallas, San Antonio, Corpus Christi, Texas, and Lafayette, Houma, Louisiana.

North & West Texas, New Mexico
General Machine & Supply So. — Odessa, Snyder, Texas.
Nortex Engine & Equipment Co.—Wichita Falls, Texas.

Kansas
Carson Machine and Supply Co.—Great Bend

Illinois — Western Kentucky
Western Machinery & Engine Company—Centralia, Illinois and St. Louis, Missouri.

LE ROI

IN THE FIELD . . .

Service Network

Michigan
Hafer Engine Service — Reed City

Rocky Mountain Area
Gehring Equipment Co. — Casper, Wyoming, Rangely, Col.

Northern Louisiana & Mississippi
Ingersoll Corporation — Shreveport, Louisiana, and Jackson, Mississippi.

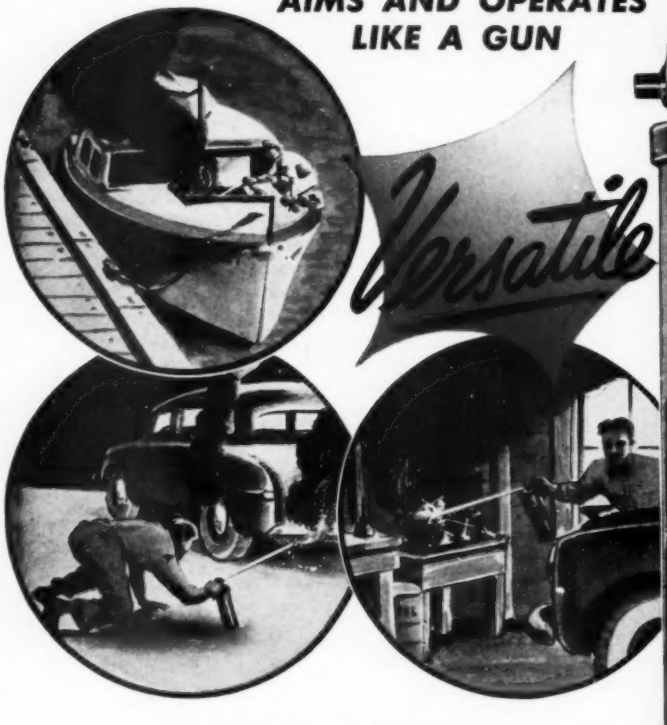
West Coast
Le Roi-Rix Machinery Co. — Los Angeles, Long Beach and Bakersfield, Calif.

Appalachian Area
P. C. McKenzie Co., Pittsburgh

Canada
Lucey Export Ltd. — Calgary, Edmonton, Alberta.

NEW 1 QUART STORED PRESSURE FIRE EXTINGUISHER . . .

AIMS AND OPERATES LIKE A GUN



ALFCO AIR PRESSURIZED FIRE-GUN

Aims like a gun . . . trigger-quick action . . . hits target instantly, accurately . . . discharges one quart of Fire-Gun Fluid . . . compressed air expelled . . . no pumping . . . excellent range 25 to 30 ft. . . . operates with one hand . . . easily recharged . . . pressurize with any standard air chuck exerting 150 psi . . . will not freeze.

This is the newest and most effective one quart fire extinguisher for Class B and C fires we have yet designed. Inspected and approved by Underwriters' Laboratories. Write for fully illustrated literature.

AMERICAN-LAFRANCE-FOAMITE Corporation
ELMIRA · NEW YORK · U.S.A.
ALFCO

RUGGED TOUGHNESS...

Velvet Smoothness

FOR HIGHER SPEEDS FASTER PRODUCTION

Sturdy, longer life built into every length of Atlas Roller Chain assures rugged toughness on every installation. The Atlas Nicarb Process used for case hardening bushings, and pins is one big reason for the stamina of Atlas "Super-Life" Chain. Nicarbing provides an outer surface strongly bound to the core of steel which provides greater strength and wear resistance.

Atlas Chain drives operate with a velvety smoothness made possible by precision made bearings rolling at every point of contact. These bearings—pins, bushings and rollers—are of specially selected steels finished by Atlas's Exclusive "Mirro-finish" process.

The result is a super-life chain that minimizes wear and repair. Greater efficiency . . . greater economy on every drive. To speed up production and cut maintenance install Atlas positive-power drives. Write for new handbook and catalog on chain drives . . . no charge, no obligation.

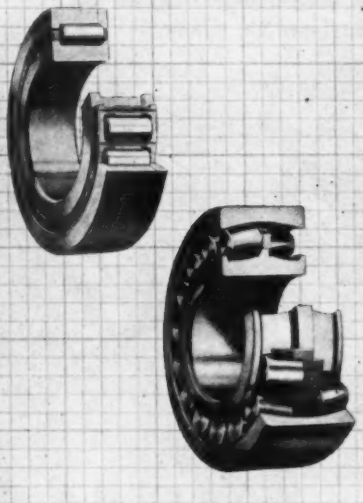
ATLAS CHAIN & MANUFACTURING CO.
Philadelphia 24, Penna.

ATLAS

ATLAS ROLLER CHAIN

TORRINGTON BEARINGS

...aid faster, deeper, cheaper drilling



Emsco D-850, largest duplex slush pump ever built, provides the high fluid volume pressures required for jet bit drilling, which is reported to be reducing hole costs as much as $1 per foot.

Torrington Spherical Roller Bearings are used on the main shaft. The radial and thrust load carrying characteristics of these heavy-duty bearings assure reliable, trouble-free operation. Their compactness is an aid to simplifying design.

Also contributing to smooth, efficient performance of these giant pumps are Torrington Radial Roller Bearings on the eccentrics and Type NCS Needle Bearings on the crossheads.

Added dependability can be built into your equipment, too, with Torrington Bearings. Our years of experience in designing and producing all major types of anti-friction bearings are available to you. Call in a Torrington engineer to help solve your next bearing problem.

THE TORRINGTON COMPANY

South Bend 21, Ind. • Torrington, Conn.

District Offices and Distributors in Principal Cities of United States and Canada

TORRINGTON BEARINGS

SPHERICAL ROLLER • TAPERED ROLLER • STRAIGHT ROLLER • BALL • NEEDLE • NEEDLE ROLLERS

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SUPERIOR'S fabrication and machine shop in Shreveport, La., offers you general machine work; a pipe finishing plant equipped to upset, thread and couple oil country tubular goods and other types of pipes; and complete fabrication service. Write for SUPERIOR'S booklet, "Save Time and Money." Learn how the "Superior Method" of pre-fabrication can mean efficiency and profits on piping jobs of the oil, gas, chemical and power industries.

Wherever there is oil and gas activity in the Mid-continent area you find a convenient SUPERIOR store or office to serve you. SUPERIOR stores are strategically located to give you dependable service and supplies in a hurry along with expert technical advice! When you need top-grade supplies and service—or the answer to an equipment problem, call your SUPERIOR store.

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NEW YORK CITY — TELEPHONE OREGON 9-3650

...a sign you can believe in

You are apt to see this sign anywhere. It might be on a 'dozer "hogging out" a raw site for a refinery in Europe or the Near East; or on a 100-ton vessel in transit to South America, Canada, or the Orient; or on the control board of a petroleum chemical plant on the Gulf Coast. It might even be as close as the cover of a proposal lying on your own desk.

But wherever you see it, it symbolizes a project in capable hands—Lummus hands. It stands securely on its world-wide record—the designing and constructing of nearly 200 units of all types for the manufacture of motor gasoline, high octane aviation fuel, and fuel oils . . . more than 115 lube oil and wax processing plants . . . over 300 units for making chemicals and petroleum chemicals . . . and a score of complete refineries and chemical plants.

It's a good sign to look for, believe in, and rely on when you buy complete, integrated engineering service for *your* next project.

THE LUMMUS COMPANY

385 MADISON AVENUE, NEW YORK 17, N. Y.

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DESIGNING ENGINEERS AND CONSTRUCTORS FOR THE PETROLEUM AND CHEMICAL INDUSTRIES

MACK TRUCKS

See You Through

• There are many good reasons why a Mack is your best truck investment during times like the present. Most important of all is the undisputed fact that Mack trucks outlast them all.

This means that with a Mack truck you can face the uncertainties of the future with assurance…confident that even if trucks should become hard to replace your Mack will see you through…that it will stay on the job delivering dependable service mile after mile and year after year.

Thousands of truck users in World War II found out by actual experience that they were indeed "Lucky to own a Mack." Whatever the future may bring, you'll find that for a sound investment in long-term reliability and operating economy there's no other truck to match a Mack.

Your nearest Mack branch or distributor will give you the full story on what "Built Like A Mack" means in *extra* long life, *extra* strength and stamina, *extra* performance and *extra* dependability.

Mack TRUCKS

…outlast them all

Mack Trucks, Empire State Building, New York 1, N.Y. Factories at Allentown, Pa.; Plainfield, N. J.; Long Island City, N. Y. Factory branches and distributors in all principal cities for service and parts. In Canada: Mack Trucks of Canada, Ltd.

Loaded with a 30-ton draw works, this big Mack six-wheeler is "seeing things through" for Stephens & Stephens, oil field haulers of Graham, Texas.

. . . STANDS ALONE!

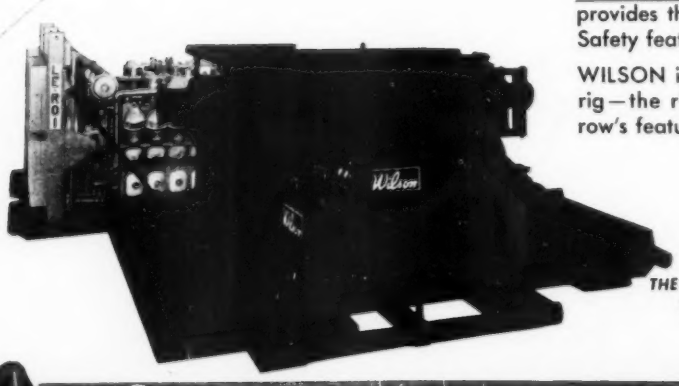
WILSON *Advanced Engineering* — above all else — has kept Wilson the Leader in the Industry.

WILSON *Advanced Engineering* makes it possible for the Contractor to make money in times of high labor and operating costs. WILSON *Advanced Engineering* allows the Contractor to make money many years after the rig has paid for itself. WILSON *Advanced Engineering* provides the maximum in Safety features.

WILSON is the Driller's rig — the rig with tomorrow's features — TODAY!

Compare Quality

Compare Prices



THE NEW WILSON TITAN RIG

Wilson MANUFACTURING CO., Inc.
WICHITA FALLS, TEXAS

6 TIMES AROUND THE WORLD

Oil keeps the wheels of industry humming in normal times—becomes the life-blood of a nation when that nation arms. Over 152,000 miles of pipe-lines, *enough to circle the world 6 times,* are needed to keep up the flow of oil. Wheatland is proud of the role played by "the pipe with the yearmark" in this vast arterial system at work to help keep the free world strong—*and free.*

-pipe with the yearmark!

WHEATLAND TUBE COMPANY

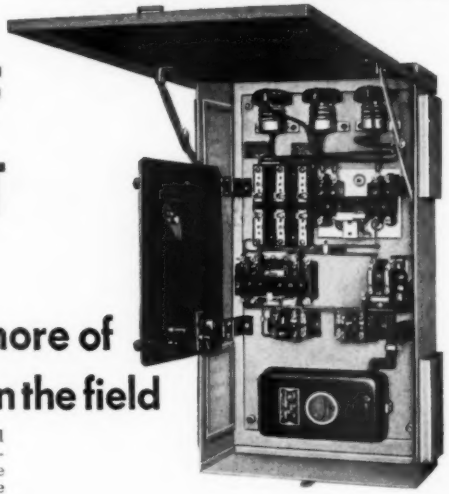
BANKERS SECURITIES BLDG., PHILADELPHIA 7, PA.

Help keep America strong and free. Get in your scrap now—*today!*

PROVED IN THE PANHANDLE

PROVED ON THE GULF

PROVED IN THE EAST



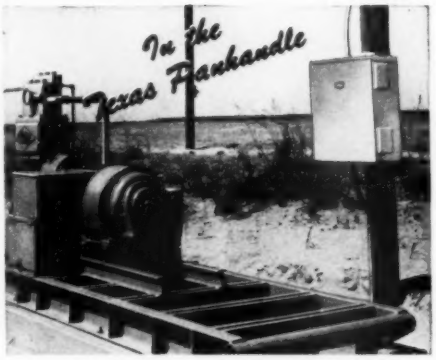
Cutler-Hammer

Oil Well Pumping Control has more of what you want than anything in the field

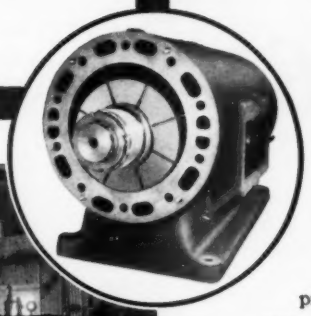
The Cutler-Hammer Oil Well Pumping Control is shaped by the special requirements of the oil country into the oilfield's outstanding well pumping control. It beats the heat. It beats the dust. It stands up in the toughest tests.

Aluminum painted enclosures beat back the sun's heat. Proper ventilation drains off the heat from inside. You don't have to prop the door open to dirt, insects and birds to keep this controller cool and working. Fine mesh screened, louvered and guarded ventilation, vertical dust-safe, dust-shedding contacts, neoprene gasketed dustproof timer enclosure, timer clock motor with excess torque—all these features keep the controller working in dustiest climates.

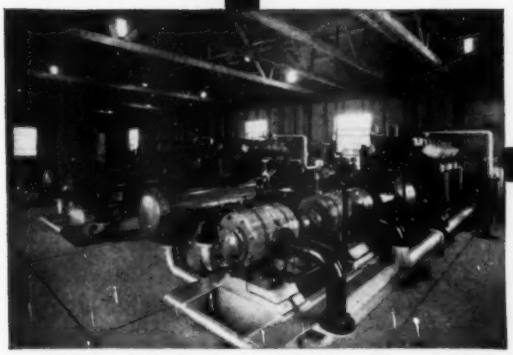
Unit type lightning arresters reveal condition at a glance. You don't have to rebuild controller if one blows. The Cutler-Hammer Controller with automatic timed restarting feature means the attendant doesn't have to reset the control after a power failure. He knows the C-H Controller will restart the motors on a safe staggered time sequence. When on-off pumping schedule is changed, the change is made simply by pulling accessible tabs, one pull for each 15-minute change—and no guessing. To reset a clock to correct time of day, attendant simply turns a handy palm size dial forward or backward. The wiring diagram with spare parts list and overload heater coil ratings is sealed in a dirt, grease, water and heat resisting plastic coat. You and your men will like these oil country starters better than any you've ever seen. CUTLER-HAMMER, Inc., 1453 St. Paul Avenue, Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ontario.



gas gets a better boost



when FULLER gets in the picture



Consider Fuller Rotary Compressors in the over-all picture of your operations. In booster work, whether for field boosting or to trunk line levels, you'll find these compressors doing a better job . . . better because they reduce maintenance cost, cut inspection time, last longer, do the job efficiently.

Pulsing and vibration, valves and complicated parts are eliminated by multi-vane rotary construction. Moving parts are few . . rotor, blades, and bearings. Blades automatically compensate for wear, ***maintaining full capacity for the life of the machine.*** These features explain why Fuller boosters do an outstanding job wherever gas is handled.

If you're interested in getting maximum efficiency and economy into your operational picture, call on a Fuller Engineer. Bulletin C-5 contains a detailed description of Fuller Rotary Compressors. Write for your copy today.

FULLER COMPANY, Catasauqua, Pa.
120 So. LaSalle St., Chicago 3
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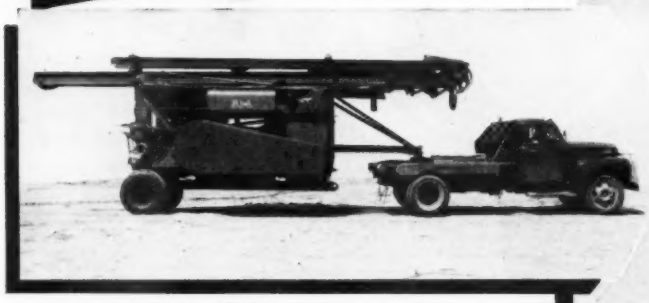
Fuller

DRY MATERIAL CONVEYING SYSTEMS AND COOLERS—
COMPRESSORS AND VACUUM PUMPS—
FEEDERS, AND ASSOCIATED EQUIPMENT

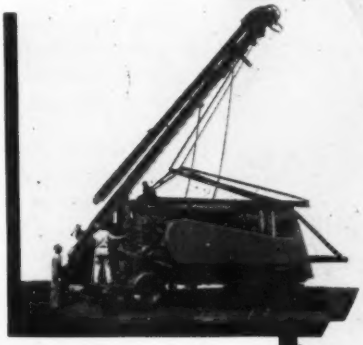
C-210

Bucyrus-Erie Spudders Give You

Extra Zip On Every Count

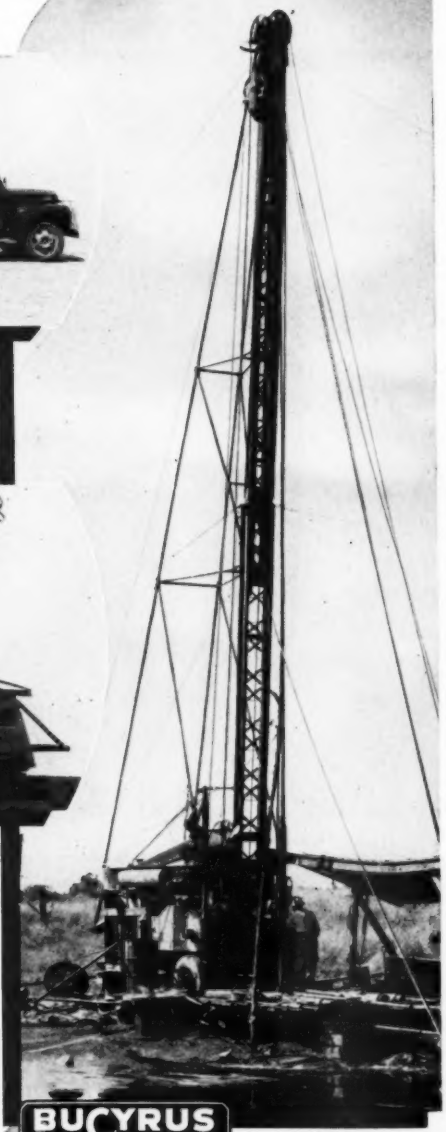


Quick Moves — Mobile semi-trailer, skid or tandem-axle mounting cuts between-job travel time to barest minimum . . . converts non-productive travel time into profitable drilling time.



Fast Set-Ups

With telescoping derrick raised and extended by power — and only 10 bolts required to fasten the complete derrick assembly — these outfits are earning money while other rigs are still being assembled.



Snappy Drilling Action — Bucyrus-Erie spudders pack a double-barreled wallop for fast footage. Spudding mechanism design "gets the beam out from under" the drill line, permitting a fast free drop of tools for penetrating impact. And the simple effective action of the rubber derrick-head shock absorbers provides the extra snap on every blow that's particularly valuable during the first few hundred feet.

Ask your Bucyrus-Erie distributor for details on these spudders — 24-L, 28-L, 36-L and 48-L. Drilling depths to 6000 feet — servicing to 7000 feet.

85681

First with the Finest in Spudders

BUCYRUS ERIE

South Milwaukee
Wisconsin

Another Example of the Trend...

Leading Refiners Are Switching to KAYLO HEAT INSULATION

The first major installation of Houdriflow "cat" crackers — a 308-ft. quadruple-reactor catalytic cracking unit — Sun Oil Company's Plant 5 at Toledo, Ohio. The entire catalyst system is insulated with Kaylo Heat Insulation.

Never before has there been an insulating material with the combination of important advantages provided by Kaylo Heat Insulation. More and more it is becoming recognized throughout industry as the first major advancement in the high-temperature field.

Kaylo Heat Insulation is a calcium silicate (not glass), an inorganic material with remarkable stability. Its high effective temperature limit—1200°F.—eliminates the need for combination covering in nearly all operating conditions.

Kaylo Heat Insulation is insoluble in water and incombustible. Its light weight and high strength make it easy to handle and apply.

KAYLO PIPE INSULATION is made to Simplified Dimensional Standards of thicknesses and diameters. Coverings are sectional for tube and pipe sizes ¼" to 12"; tri-segmental up to 23"; quad-segmental up to 41"; K-segmental (18" wide segments) up to 72" in diameter.

KAYLO HEAT INSULATING BLOCK is made in all standard sizes and thicknesses from 1" to 6" for flat surfaces and for vessels larger than 60' in diameter; curved block 18" wide for smaller vessels.

SEE OUR CATALOG IN THE REFINERY CATALOG

For complete details on Kaylo Heat Insulation, write Dept. N-162, Owens-Illinois Glass Company, Kaylo Division, Toledo 1, Ohio.

KAYLO® ... *first in calcium silicate*

...*pioneered by* OWENS-ILLINOIS Glass Company

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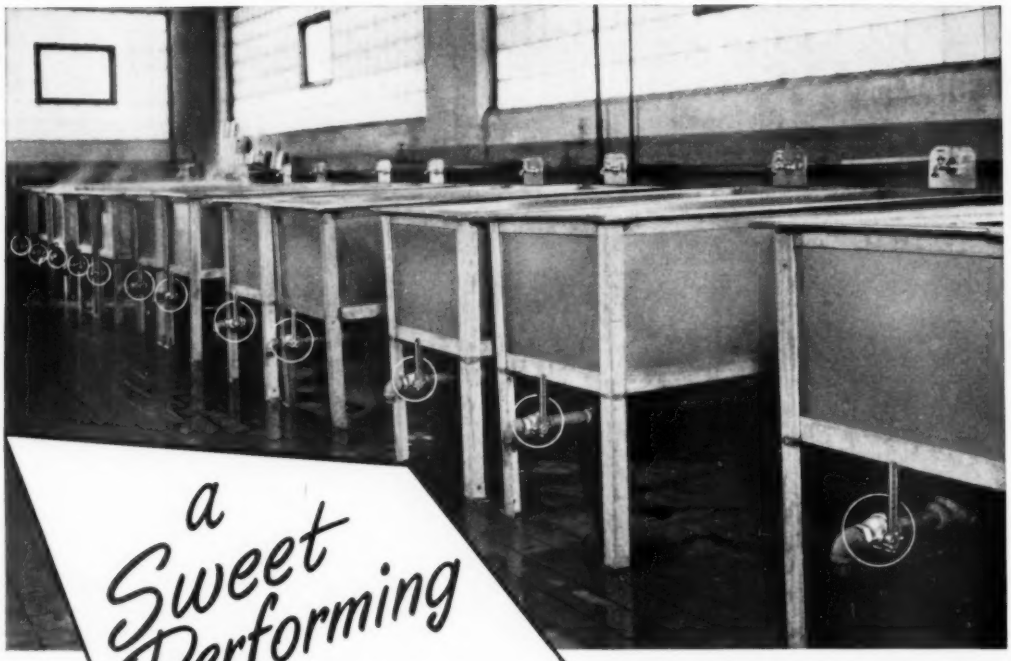


a Sweet Performing Valve

PROCESSING TANKS FOR CHERRIES AND SYRUP AT DAGGETT CHOCOLATE COMPANY, CAMBRIDGE, MASS.

These tanks at the Daggett Chocolate Company process thousands of gallons of syrup and cherries. The syrup and cherries are used to make Daggett candies and are also supplied to ice cream manufacturers and bakeries. Rockwood Ball Valves help keep these tanks in operation by giving longer and better trouble-free service. These Valves are constantly in use and have been on the lines for over 2 years — and during that time required *no maintenance.*

Floors are kept clean because when Rockwood Ball Valves are closed, they close tight and prevent syrup from dripping. Other makes of valves leaked as sugar would get into the valve slot and prevent a tight seal.

Rockwood Ball Valves are also used to draw-off corn syrup and on draw-off lines on cooking kettles.

Remember — every Rockwood Valve is designed and built to outlast any other valve on the market. See your distributor — see for yourself that Rockwood Ball Valves have the best engineering features your money can buy. Look for these outstanding features when you buy your valves — leak proof service, full *round* flow, easy operation, no maintenance.

Rockwood Ball Valves are recommended for 300 p.s.i. working pressure. Thousands of Rockwood Ball Valves are in service in oil refineries, food, paper, textile, chemical and rubber plants, etc. Write today for prices and sizes.

Distributors in all principal cities.

2" Rockwood Ball Valve on corn syrup draw-off line. Tight seal of floating ball against synthetic seat prevents syrup from dripping on floor.

ROCKWOOD

ROCKWOOD SPRINKLER COMPANY
104 HARLOW STREET
WORCESTER 5, MASS.

Century

Motors Will Do a Reliable 3-Shift Job Every Day

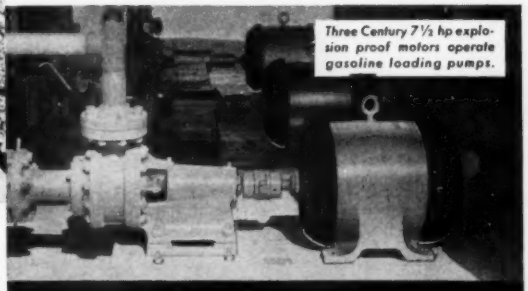
From the wide range of types and sizes you may select a variety of motor specifications for each job.

Century 10 horsepower Splash Proof motor driving a pumping unit located in Texas.

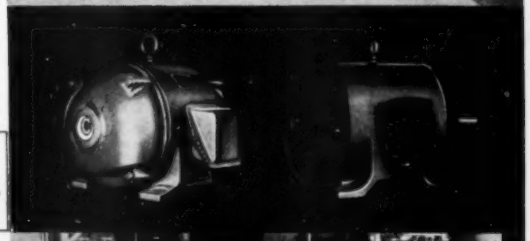
- ***Torques and current characteristics tailored to the job function.***
- ***Frame protection for a variety of hazardous surroundings.***

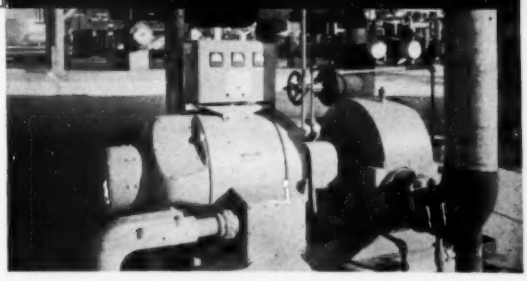
For Oil Production: Century Splash Proof Motors are widely used for pump rigs out in the open weather in any climate in the U. S. — Type SCT high torque, high slip, operating characteristics start stiff pumps and minimize shock reaction to pump parts by absorption.

For Refining and Distribution: Century "Underwriters approved" Explosion Proof, Totally Enclosed Fan Cooled Motors, protect life and property in explosive atmospheres and are also offered in a variety of torque characteristics tailored to your job function.



Three Century 7½ hp explosion proof motors operate gasoline loading pumps.





Century motors are distributed in the oil fields through your regular equipment stores or through Century's 28 branch offices.

CENTURY ELECTRIC CO.

1806 Pine St. • St. Louis 3, Mo.

Offices and Stock Points in Principal Cities

Century Electric Company is celebrating its 50th year in the electrical industry.

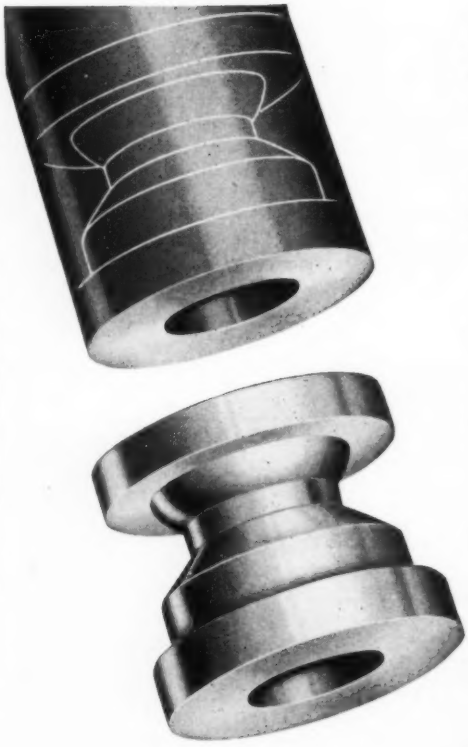
Century C MOTORS

Century Type ARC Generator

Where public service current is not available, Century Generators will provide adequate, continuous electric power. Depending on the load per motor and the size of generator, from 10 to 30 wells can be operated from one generator. They provide a dependable source of oil field power.

714

How hollow-parts makers can save steel now



BY using Timken® seamless steel tubing instead of bar stock to make hollow cylindrical parts, you eliminate the drilling operation. This saves all the metal that's wasted in drilling a center hole in bar stock. You get more finished parts out of a ton of steel.

MOST ECONOMICAL SIZE TUBING

Still more steel is saved by the Timken Company's tube engineering service. Working with your specifications for your finished parts, we calculate the most economical size tubing for the job, *guaranteed* to clean up to your dimensions.

COST REDUCED, QUALITY IMPROVED

With Timken seamless steel tubing, finish boring is usually the first production step. Drilling is entirely eliminated. Machining time is saved. Costs are cut.

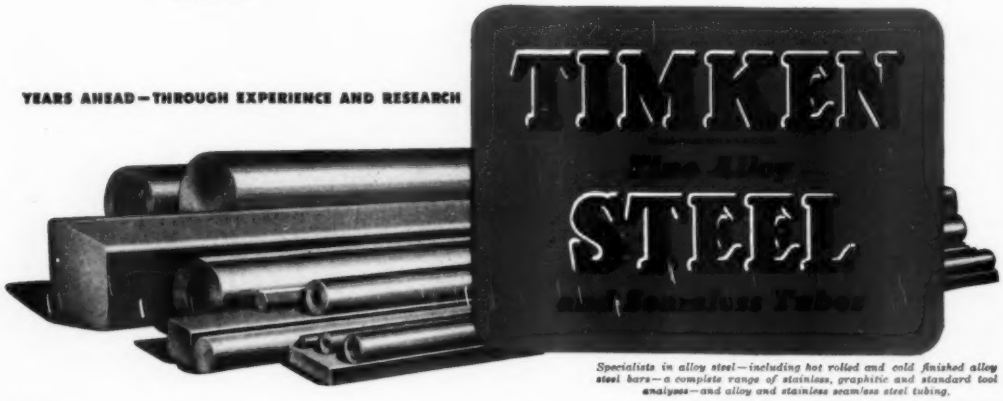
Quality is improved too, because the piercing process by which Timken tubing is made is basically a forging operation. This gives the tubing a uniform spiral grain flow for greater product strength and a refined grain structure that brings out the best in the quality of the metal.

UNIFORMITY ASSURED

Uniformity throughout the length of the tube is assured by the speed of the piercing process (one foot per second) which prevents heat loss. And rigid quality control from melt shop through final inspection maintains uniformity from tube to tube, heat to heat.

If you're looking for ways to save steel, cut costs and improve quality, ask for an "on the job" analysis by our Technical Staff. Write The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH



Specialists in alloy steel—including hot rolled and cold finished alloy steel bars—a complete range of stainless, graphitic and standard tool analyses—and alloy and stainless seamless steel tubing.

News for the Southwest

ALCO Exchangers, now built in Texas

faster service, greater convenience, more time saved

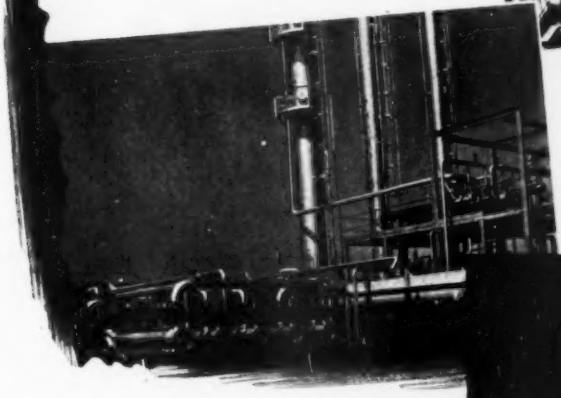
At the **Beaumont Iron Works,** in the heart of the Southwest, engineers and designers who know oil, and understand its requirements, are now building ALCO heat exchangers. To the quality and dependability of these exchangers is now added the advantages of a strategic location—savings in time and greater convenience.

Put these extra values to work for you by calling in the ALCO-BIW representative when you need heat exchangers. The Beaumont Iron Works Company—Beaumont, Texas—is a subsidiary of the American Locomotive Company.

SPECIAL EXCHANGER EQUIPMENT. For years ALCO has successfully handled the problems connected with large or special heat exchanger equipment.

CAREFUL CONSTRUCTION. ALCO's long years of experience are your guarantee of quality that's built into every one of these heat exchangers.

PROVEN PERFORMANCE. In numerous installations like this large Southwestern natural gasoline plant ALCO exchangers prove their mettle in the toughest test of all—actual operation in the field.

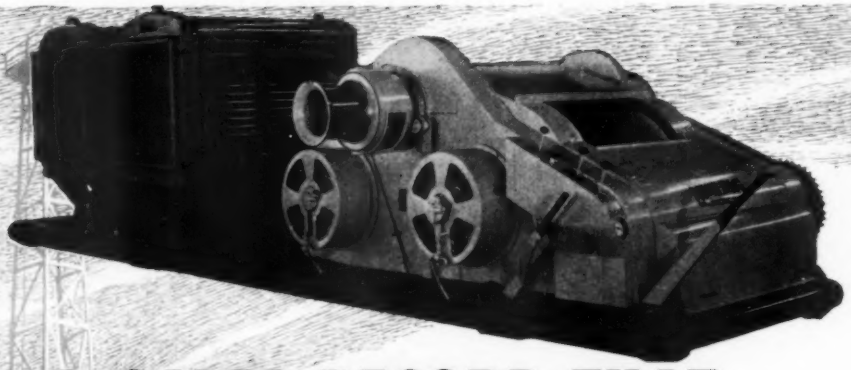


***In step with tomorrow*—ALCO AIRCOOLERS, Heat Exchangers, Evaporators, Feedwater Heaters, Pressure Vessels, Pipe**

ALCO

ALCO Products Division

AMERICAN LOCOMOTIVE COMPANY



A SALES RECORD THAT PROVES ACCEPTANCE

Since the U-34 was introduced in April, 1948, over seventy of these models have been put into operation. Approximately 30% of the units sold were reorders by satisfied users. Where can you find an acceptance record as good as this for a brand new drawworks?

SPECIAL FEATURES OF THE U-34 AND U-34D

VERSATILITY — Single or double-drum models. One or two engines. One package unit or split-rig unit make for many combinations to suit your individual needs.

SPEED — Fast operating combination because each engine is equipped with a torque converter which allows each engine to reach high speeds QUICKLY where maximum Horse Power is attained.

SAFETY and SIMPLICITY — All controls designed for the convenience of the operator. Self-energizing, fully equalizing, one point adjustable brakes. Self-cooling Air-O-Matic clutch requires no adjustment. One-lever control for all drum speeds. Unique design of control and drum clutches practically eliminates clutch failure.*

PORTABILITY — Designed so drawworks and power unit may be transported in one load, thus reducing moving costs and time.

*One set of clutches shows slight wear after 90,000' of drilling. To March, 1951 only one clutch failure —caused by low air pressure.

UNITRIG & EQUIPMENT CO.
TULSA, OKLAHOMA U.S.A.

DESIGNED FOR THE JOB....

UR-514

UNIT BIG DRAWWORKS ARE SOLD EXCLUSIVELY THROUGH THESE AUTHORIZED DISTRIBUTORS IN THE USA AND CANADA

BOYARD SUPPLY COMPANY
HOUSTON OIL FIELD MATERIAL COMPANY
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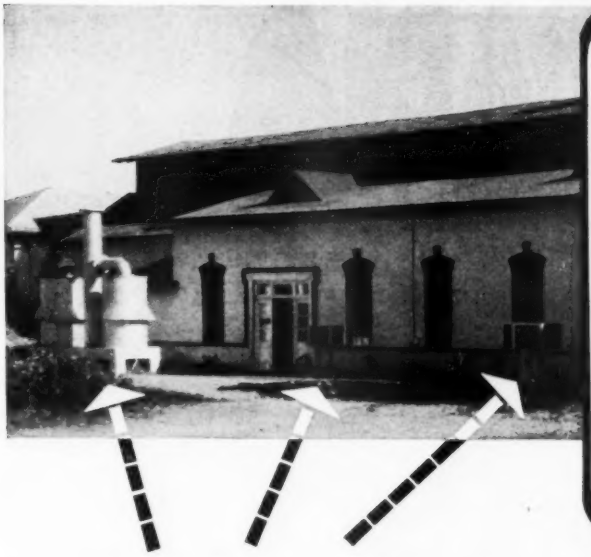
MID-CONTINENT SUPPLY COMPANY
NORVELL-WILDER SUPPLY COMPANY
OIL WELL SUPPLY COMPANY

EXPORT SALES — MID-CONTINENT SUPPLY COMPANY, 42 Broadway, New York City. Cable — MIDUNITRIG



CLEAN AIR HELPS PAY for 400-Acre PARK

AAF Filters Contribute to High Profit Operation of Kansas Power Plant

The municipal power plant of Garnett, Kan., serves a community of only 2500 people, yet it netted a profit of $141,962.00 from 1945 through 1949. A portion of these earnings were used to develop a 400-acre park complete with swimming pool, golf course, football field and stadium.

The secret of this success story—low maintenance costs in which filtered air played an important role. Three of the four diesel engines are equipped with AAF Type "OC-H" washable, unit-type filters—the fourth and newest engine with a duplex Cycoil Oil Bath Air Cleaner. The oldest engine dating back to 1925 was only recently rebuilt and is now operating 2000 hours yearly. Another engine installed in 1930 has run more than 70,000 hours and still retains its original pistons and cylinder liners.

Here's convincing proof that clean air can pay a handsome profit—of AAF filters' ability to deliver continuous high-efficiency cleaning service. There's an AAF filter of a type and capacity designed to convert your dust into dollars. Write today for complete product literature.

Today's Best Buy is Better Air!

AAF

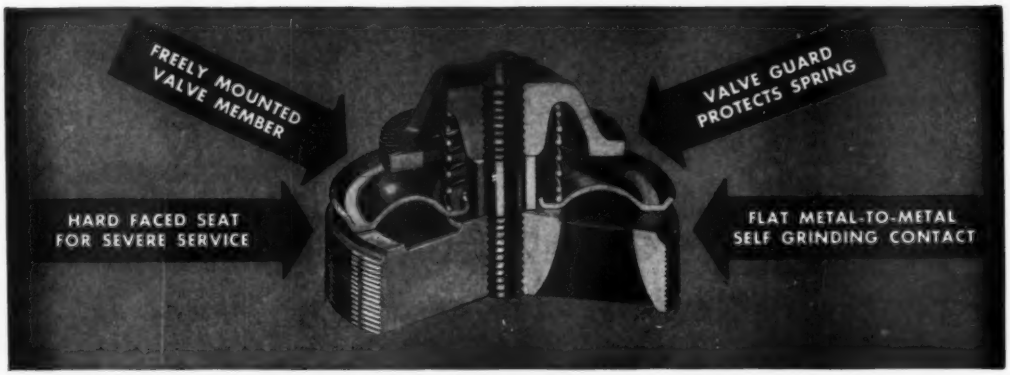
American Air Filter

COMPANY, INC.

444 Central Avenue, Louisville 8, Kentucky • Darling Bros., Ltd., Montreal, P.Q.

DURABLA

METAL PUMP VALVE UNITS
KEEP YOUR PUMPS IN SERVICE


FREELY MOUNTED VALVE MEMBER
VALVE GUARD PROTECTS SPRING
HARD FACED SEAT FOR SEVERE SERVICE
FLAT METAL-TO-METAL SELF GRINDING CONTACT

1 **THEY ARE SELF-GRINDING:** Durabla Valve Units*, utilizing the freely mounted arched construction valve member exclusive to Durabla, are self-grinding, as the flat portion of the valve member is in direct contact with the flat valve seat and is free to move about its axis, thus producing a constant self-grinding action.

2 **VALVE SEATS ARE HARD FACED FOR SEVERE SERVICE:** Providing a seat surface hardness of Rockwell C-48-52 (approximately 500 Brinnel) or more in special valves, Durabla Valve Units have a long record of effective service with FLUIDS CARRYING SUSPENDED ABRASIVE SUBSTANCES. The metal valve member effectively prevents the pitting or "pick-up" of abrasive substances sometimes occurring with valves made of other materials.

3 **VALVE SPRINGS AND VALVE STEMS ARE PROTECTED:** The Valve Guard protects the Valve Spring from ever compressing more than 50% of its length. The Valve Stem is protected against breakage by the free mounting of the Valve Member.

Economy, efficiency and adaptability, based on long established service records and exclusive design make Durabla Valves your guarantee of reliable, uninterrupted pump operation.

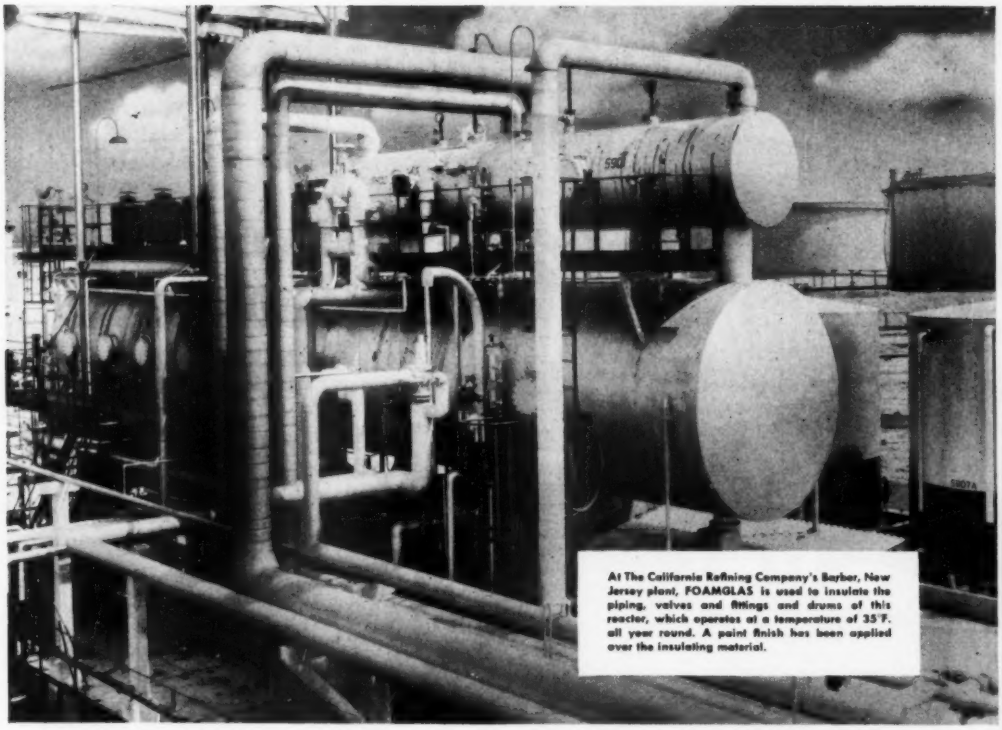
You can specify Durabla Valves when you order a pump, (many manufacturers use them as standard equipment), or you can order Durabla Valves to fit any type of reciprocating pump, (they come with drive-fit seats or threaded seats with or without a shoulder to suit the job).

TO AVOID "PUMP TROUBLES" SPECIFY DURABLA VALVES

Address DURABLA Engineering Department for information and bulletin: Reference OG-7

*Patent Numbers 2090486, 2117504

DURABLA MANUFACTURING COMPANY
114 LIBERTY ST. NEW YORK
BRANCHES IN PRINCIPAL CITIES. FOR CANADA REFER: CANADIAN DURABLA LIMITED, TORONTO



At The California Refining Company's Barber, New Jersey plant, FOAMGLAS is used to insulate the piping, valves and fittings and drums of this reactor, which operates at a temperature of 35°F. all year round. A paint finish has been applied over the insulating material.

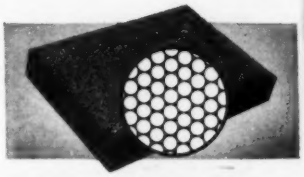
Save cold cash . . . when the heat is on!

● It takes an exceptional insulating material to keep this processing equipment operating at near-freezing temperature in hot summer weather. Yet FOAMGLAS is handling the job—and countless others like it—effectively and economically.

Its unique physical properties enable this cellular glass insulation to give long lasting, satisfactory service on tanks, drums and towers, on indoor and outdoor piping, valves and fittings, on heat exchangers, evaporators and other processing equipment in many prominent refineries and processing plants.

When you are concerned with keeping temperatures—and insulating costs—at low levels, be sure to look into the possibilities of FOAMGLAS, the cellular glass insulation. Write for free sample and informative booklet.

PITTSBURGH CORNING CORPORATION
PITTSBURGH 22, PA.



The best glass insulation is cellular glass. The only cellular glass insulation is FOAMGLAS. This unique material is composed of still air, sealed in minute glass cells. It is light weight, incombustible, verminproof. It has unusually high resistance to moisture, chemicals and many other elements that cause insulation to deteriorate.

PITTSBURGH PC CORNING ®

FOAMGLAS® *the cellular glass insulation*

When you insulate with FOAMGLAS — the insulation lasts.

Pittsburgh Corning Corporation
Dept. DD-71, 307 Fourth Avenue
Pittsburgh 22, Pa.

Please send me without obligation your FREE booklet on the use of FOAMGLAS for industrial insulation, and a sample of the material.

Name.....

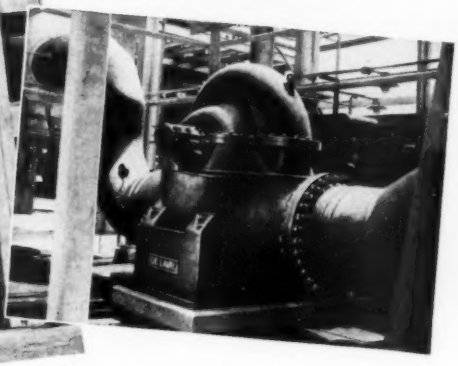
Address.....

City.....State.....

De Laval Centrifugal Blowers

go on-stream in

first new design HOUDRIFLOW PLANT



New Bulletin NO. 0500 fully describes top-performance, maintenance-saving features of De Laval blowers *plus* data that make it virtually an engineering handbook on compression of gases and pipe friction. We have a new bulletin (No. 4215) on our high pressure mechanical drive turbines. Ask for a copy of it also.

ANOTHER DE LAVAL FIRST *

LOCATION: California Refining Company, Perth Amboy, N. J.

PROCESS: Houdriflow catalytic cracking.

ENGINEERED BY: C. F. Braun & Co.

DE LAVAL EQUIPMENT: Two 38,750 cfm single-stage, double-suction blowers, each driven by a De Laval "MCP" single-stage, high back pressure turbine. Operating conditions are 600 psi, 750F, 150 psi back pressure.

FUNCTION: Blowers discharge air at pressures to 5.3 psig for regeneration of the spent catalyst.

* De Laval "firsts" in blowers and compressors date as far back as 1902.

50th Anniversary

DE LAVAL STEAM TURBINE CO., TRENTON 2, N. J.

TURBINES • HELICAL GEARS • CENTRIFUGAL BLOWERS AND COMPRESSORS
CENTRIFUGAL PUMPS • WORM GEAR SPEED REDUCERS • IMO OIL PUMPS

DL 100

SMOOTH running

Condor V-BELTS

"Smoothest running V-Belts we've ever had," users say. "... and they smooth out our production problems, too!"

Smooth running is no accident in Condor Whipcord V-Belts. For example, we micro-position the pulling section so that it stays in the neutral axis area, where engineering practice says it should be. With every belt so precision-made, a Condor Multiple V-Belt drive is bound to be a smooth running team.

Bulletin 6868 D, mailed on request, describes all advantages to you of Condor Whipcord V-Belts.

You'll find this same good engineering also in our hose, flat belting and conveyor belts. Just phone your R/M Distributor.

MANHATTAN RUBBER DIVISION — PASSAIC, NEW JERSEY

RAYBESTOS-MANHATTAN, INC.

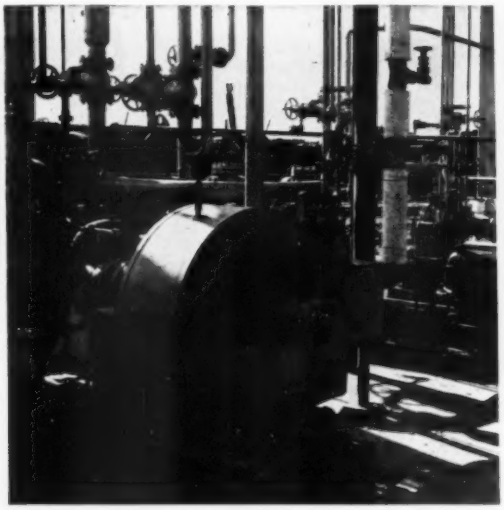
Manufacturers of Mechanical Rubber Products • Rubber Covered Equipment • Radiator Hose • Fan Belts • Brake Linings • Brake Blocks • Clutch Facings • Packings • Asbestos Textiles • Powdered Metal Products • Abrasive & Diamond Wheels • Bowling Balls

WHY STANDARD DP TURBINE DRIVES FIT ALMOST ANY APPLICATION

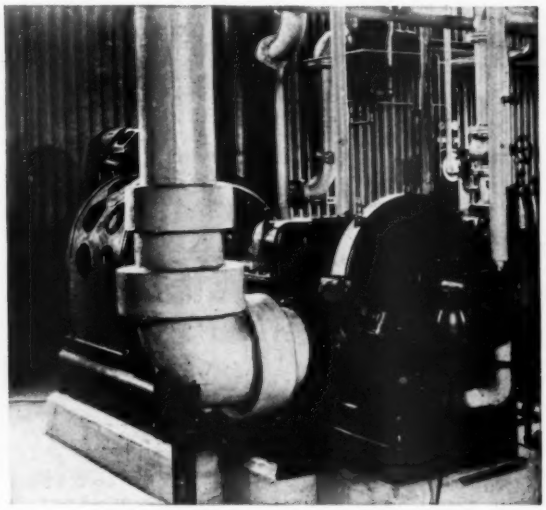
Here's a turbine designed by turbine users. It incorporates the features asked for by hundreds of operators interviewed in an exhaustive survey. They told General Electric they wanted a mechanical-drive turbine that would fit many types of applications—continuous process, standby, indoor, outdoor, equipment drive, generator drive, etc.

The DP answers these varied requirements with special features that are included as standard parts. For instance, you get hydraulic governing to meet critical accuracy requirements, totally enclosed construction that allows installation in hazardous atmospheres, pressure lubrication for dependable, continuous operation. These advantages are included at no extra cost—the DP is priced as a standard.

If you have steam available, the DP turbine can work profitably for you. You'll discover how its standard design gives you wide application flexibility, makes possible real savings in maintenance costs. The DP's operating record proves its reliability when there's a tough job to be done.



OUTDOOR INSTALLATIONS—No need to make special modifications when you move a DP out of doors. Totally enclosed governing system operating in its own oil atmosphere eliminates possibility of rusting or corrosion. You can operate a DP in hazardous atmospheres. Positive acting, non-sparking emergency governor protects the DP turbine against overspeed.



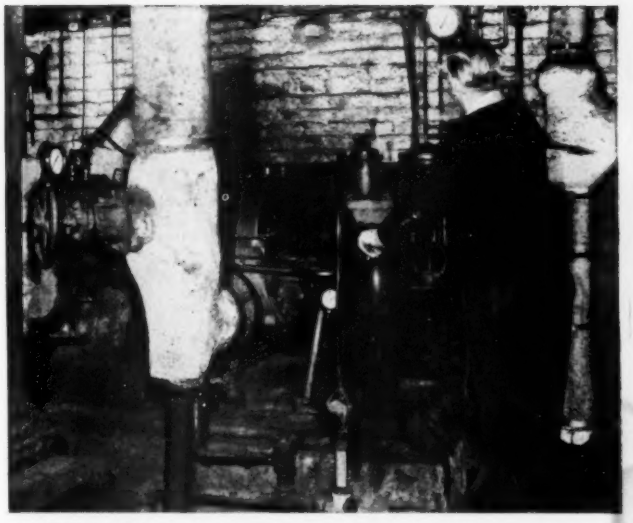
PRECISION GOVERNING—accurate enough for generator drives—is yours with the DP's hydraulic system. Regulation is 6 per cent with a 30 per cent range of speed adjustment. For process governing, regulator control is available.

Ask your General Electric representative for full details about the DP mechanical-drive turbine, or write for bulletin GEA-4955, General Electric Company, Schenectady 5, New York.

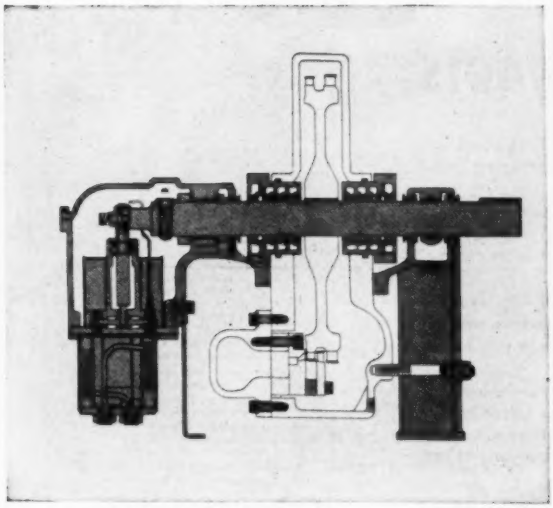
GENERAL ELECTRIC

252-50

MECHANICAL-DRIVE TURBINES



DEPENDABILITY is built into the DP. Positive lubrication through automotive-type bearings adds years to the life of the turbine. Special steel nozzle plate, self-lubricating graphite packings, and Monel-sprayed shaft are examples of design features that spell reliability.



APPLICATION FLEXIBILITY As the shaded parts in the diagram illustrate, most DP parts are identical on all frame sizes and ratings. In this way, you can adapt a DP for different job requirements with only minor changes. A different nozzle plate gives you a new horsepower output. A change in governor gears provides a new speed range. DP's are rated from 10 to 1200 HP and 1000 to 5000 rpm, and with slight modification, can deliver up to 2000 HP and 10,000 rpm. During a change in plant operation, the DP's flexibility will save you money.

EASY MAINTENANCE Because most parts are interchangeable on all models, spares can be stocked at low cost. A spare parts kit, containing 91 items, can be obtained with the turbine. This simple method of stocking spares lowers maintenance costs and provides protection for several DP's in your plant. All models, regardless of frame size, horsepower, or speed ratings, have identical shaft height, keyways, and coupling fits. Thus, installation problems are simplified; you can move these center-line supported units from job to job without a custom line-up.

ANOTHER NOTABLE ACHIEVEMENT IN SERVICE LITERATURE BY JENKINS

THE NEW

BOOK No. 2

Nos. 26—50

practical piping layouts

The second series of twenty-five basic Piping Layouts (published by Jenkins Bros. in leading industrial, professional, and engineering publications) is now available in booklet form.

If you are among the hundreds of valve-users who received a copy of the first book, or if you saved any of the fifty Jenkins Piping Layouts as they appeared, then you know how helpful this information can be in planning any valve installations.

This new book brings you not only 25 practical piping layouts, arranged in convenient form for quick reference. It also includes a section on the fundamentals of valve design and application to help you select the type of valves best suited for the service.

Use it as a guide to proper valve selection and placement for longest service life and lowest operating costs. Use it also for an introduction to the wide range of Jenkins Valves for every industrial engineering and plumbing-heating service. You can obtain a copy by requesting it on your business letterhead. Address:

Dept. W, Jenkins Bros., 100 Park Ave., New York 17, N. Y.

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JENKINS VALVES

LOOK FOR THE DIAMOND MARK

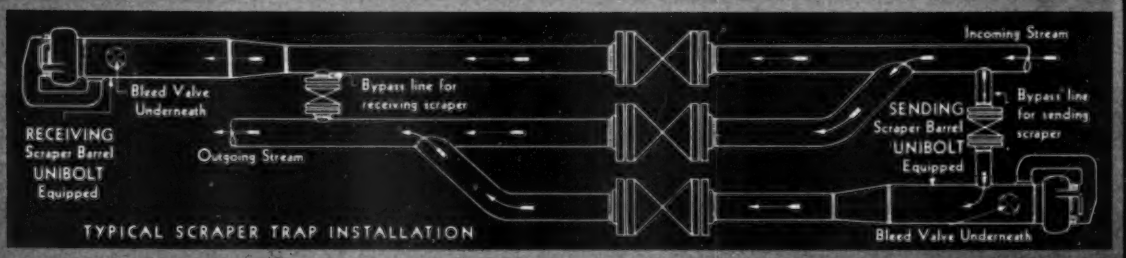
SINCE 1864 TRADE JENKINS MARK

Jenkins Bros.

Sold through leading industrial distributors everywhere

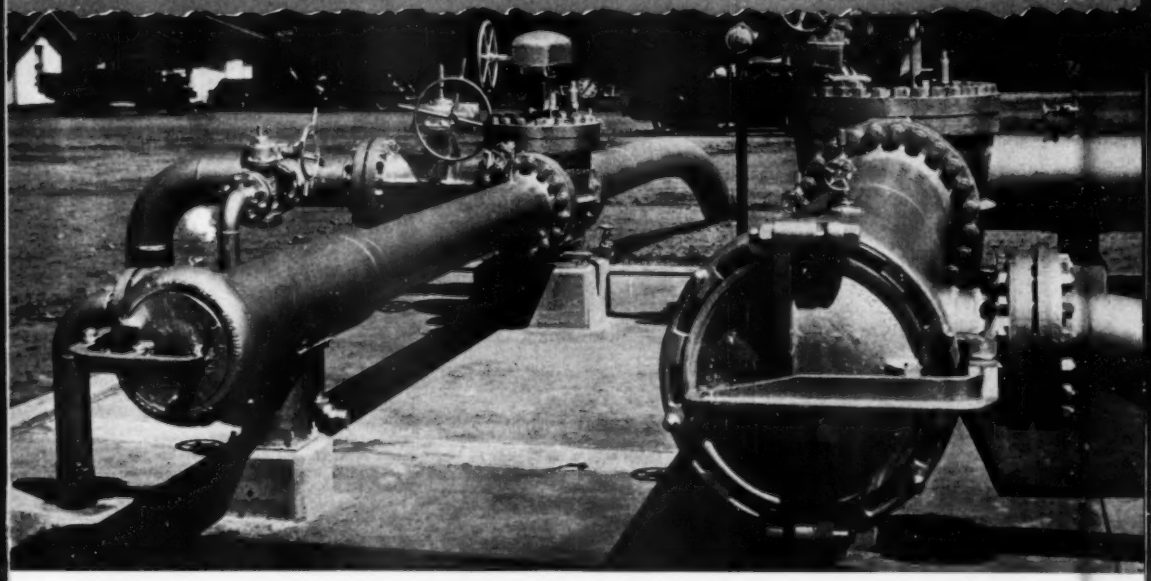
THIS SECTION DOUBLES ITS VALUE TO YOU!

Tells "Which valve where, and why"—with information in chart form for quick reference. A compact manual that will be prized by everyone, beginner and veteran alike, who plans piping.



TYPICAL SCRAPER TRAP INSTALLATION

THE EASY WAY TO CATCH A PIG!



The oversize barrel does the trick. Note in the above sketch of a typical scraper trap installation how an oversize barrel on both the sending and receiving ends of the line provides ample clearance for the pig (which has the same o. d. as the pipe in which it is run). No sidebooms, tractors, rams and strongarm men required. Line pressure does the heavy work.

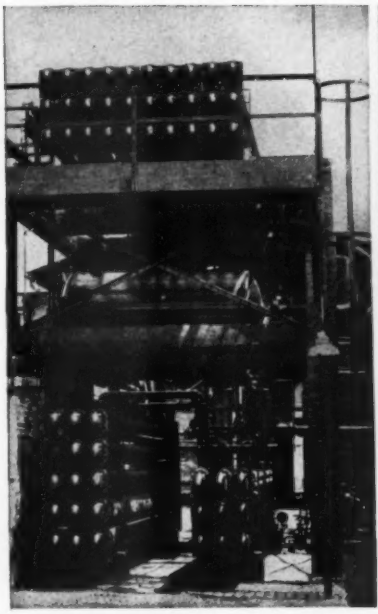
But that's only half of the story. To further simplify the job, all you need do to open the UNIBOLT Hinged Scraper Trap is release two bolts and the blanking plug swings open like a door. No heavy lifting. Nothing to fall on workmen. No time-consuming blind flanges to make up. No danger of leaks — the UNIBOLT self-sealing oil-resistant seal ring assures a pressure-tight seal.

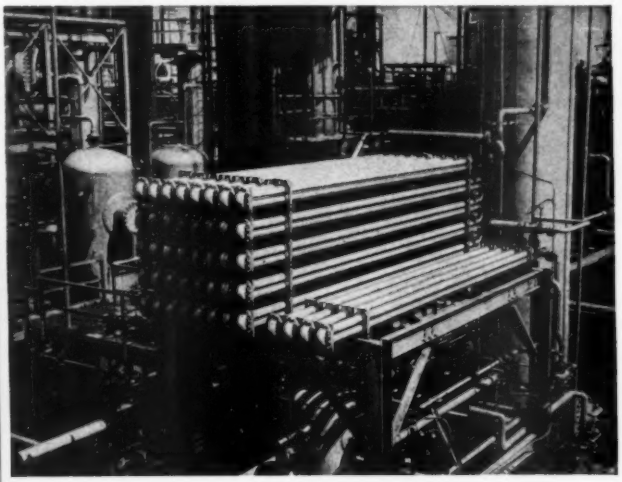
UNIBOLT SCRAPER TRAP with oversize barrel

Wherever multi-bolt flanged couplings and closures are now being used . . . on strainers, scrubbers, mist removers, terminal manifolds, blowdowns or other pressure vessels . . . UNIBOLT Couplings will serve you better. Send for literature.

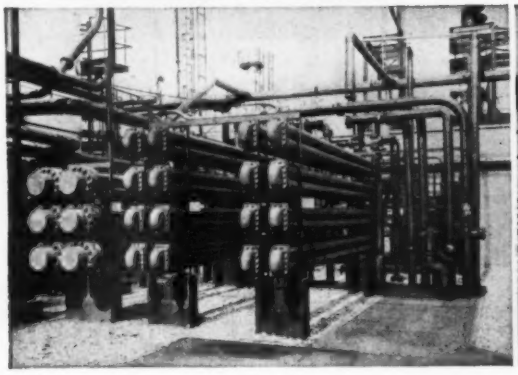
THORNHILL-CRAVER COMPANY • HOUSTON, TEXAS

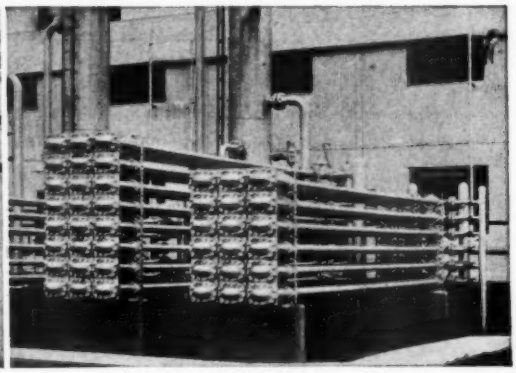
HEAT EXCHANGERS





Notice the flexibility in installed arrangement of G-R Twin G-Fin Sections as shown by the illustrations. Many concerns are using several hundreds of Twin G-Fin Sections on heat transfer duties all over the plant because of their unequalled adaptability to a wide range of service requirements.





GRISCOM-RUSSELL: PIONEERS IN HEAT TRANSFER APPARATUS

you can take "off the shelf"

Have you ever thought how convenient it would be to be able to "stock" heat exchangers . . . just as you do with valves, fittings and bolts . . . so as to have them ready as quickly as you need them for heat transfer services?

You can do it with the G-R Twin G-Fin Section . . . the multi-purpose heat exchanger. These units can be set up in stacks just like a sectional book-case. They can be grouped in parallel or series for complete flexibility of capacity and temperature range. You can use them for practically any condensing, cooling, heating or heat exchange service. They are easily and quickly transported and piped up.

When you need a new heat exchanger, just write, phone or wire us to ask the Twin G-Fin Section set-up that will do the job. If the service conditions of an existing Twin G-Fin Section installation are changed, it's a simple matter to add or remove one or more sections. And if an existing installation is no longer needed because of process changes, the units can be disconnected and returned to the storeroom for "stock", to be held until the next call for heat exchangers.

Many plants are already doing this. These plants need not wait for specially designed and manufactured heat exchangers for most of their services, nor do they have to pay the cost of "tailor made" units.

Just think of the advantages for your own plant . . . and write us for full information.

ADVANTAGES OF THE

G-R TWIN G-FIN SECTION

1. SIMPLE . . . just the patented G-Fin pipe within a shell. The patented stationary head closure has only 3 parts.

2. EFFECTIVE . . . the famous longitudinal G-Fins have 6 to 11 times as much external heat transfer surface as bare tubes, requiring less surface for a given duty.

3. STURDY . . . designed for pressures up to 1800 psig. The heat transfer elements are pipes of standard thickness, not thin gauge tubes.

4. DURABLE . . . proven by the operating results of more than 50,000 installed units, some of which have been in service for as long as 15 years.

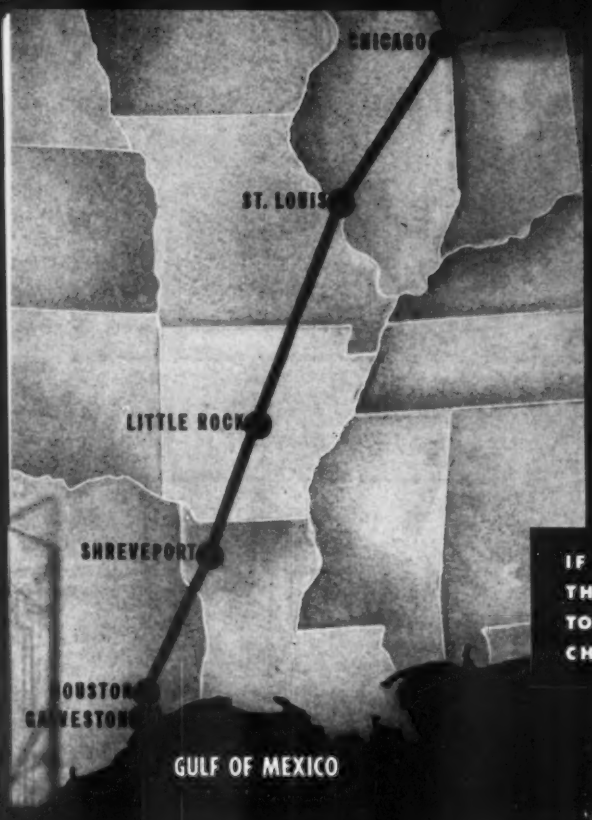
5. CONVENIENT . . . easily transported . . . easily installed . . . easily maintained.

6. ADAPTABLE . . . G-Fin elements and fins can be made of any ferrous or non-ferrous alloy regularly used in heat exchanger service.

THE GRISCOM-RUSSELL CO., 285 MADISON AVE., NEW YORK 17, N. Y.

GRISCOM-RUSSELL

GR-258



Schlumberger

offers you

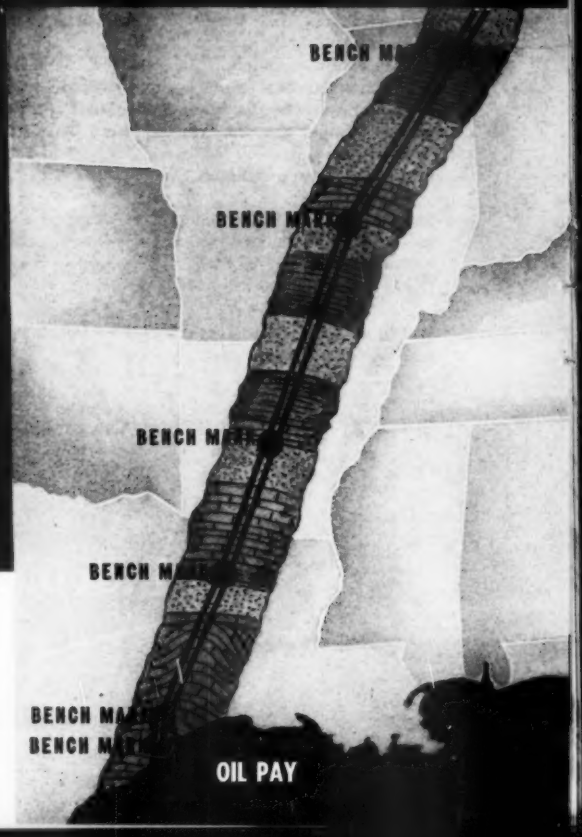
POSITIVE DEPTH CONTROL

on your

PERFORATING OPERATIONS

IF YOU WERE ASKED TO GIVE THE DISTANCE FROM HOUSTON TO GALVESTON, WOULD YOU BRING CHICAGO INTO THE PICTURE?

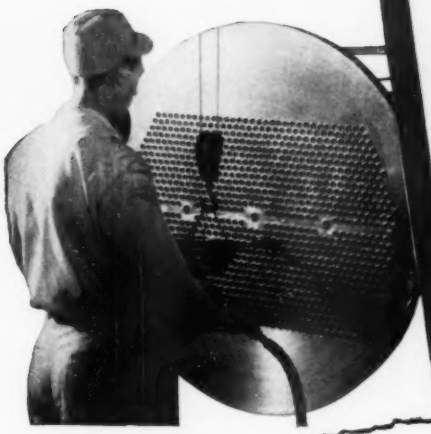
Then why depend on derrick floor measurements to perforate your oil well? Use Schlumberger Electrical Logs, Gamma Ray Logs, and Casing Collar Logs to obtain positive depth control for well completions by establishing natural bench markers in the hole. Ask your Schlumberger Engineer for details of how you can take maximum advantage of these dependable Schlumberger services.



SCHLUMBERGER

SCHLUMBERGER WELL SURVEYING CORP.

HOUSTON, TEXAS



What the experts demand...

ELECTRUNITE

Pressure Tubes provide!

Expanded Tube Joints

The making of expanded tube joints in tube sheets of unfired pressure vessels was discussed in a paper by **F. F. Fisher** and **G. J. Brown**, both of The Detroit Edison Company. The authors reviewed present-day practice of rolling-in such tubes and presented information gained from installing, retubing, testing and repairing many types of heat-exchangers.

They recommended that the optimum degree of expanding be determined by tests conducted in advance of actual rolling operations and that the information so obtained be recorded and made available to others. Preference is given to the automatic relay-operated technique for uniform tube rolling.

As to the finish to be given tube holes, it was pointed out that rolled joints are primarily friction joints and that their holding strength depends upon the pressure and roughness between the contacting surfaces. On the other hand, pressure tightness is best obtained by use of smooth contact surfaces. For example, relatively rough tube holes can be used in heat-exchanger work if the tubes are much softer than the tube sheet. But if the tube material is hard, greater movement is produced between the contacting surfaces, and the axial flow of tube metal may shear or smooth off any roughness of the tube hole. For this reason the tube holes in boiler construction are reamed cylindrical and smooth and the reinforcing grooves are placed near the zone of minimum movement of the tube metal.

In order to bring out the full strength of a joint without undue distortion or damage to the tube sheets and headers, the tube metal should be softer than that of the tube sheets or headers.

When power engineers describe the qualities they want in pressure tubes, it all adds up to a description of ELECTRUNITE Tubes. Look, for example, at the list of desirable properties abstracted from the paper delivered by F. F. Fisher and G. J. Brown, of Detroit Edison Company, at the Seventy-first Annual ASME meeting in New York . . .

PROVED . . . Over 250 million feet of ELECTRUNITE Pressure Tubes are in service in boilers, heat exchangers and condensers of all sizes, output, and types. Republic's research and experience assure you of field-proved tubes for every requirement.

SMOOTHNESS . . . tube contact surfaces are smooth and free from rolled-in scale and scale pits. Because ELECTRUNITE Pressure Tubes fit tube-sheet holes accurately, they roll-in tighter every time.

DUCTILITY . . . no other pressure tube can give you more ductile properties than ELECTRUNITE Tubes. They bend smoothly and uniformly to permit rapid fabrication and trouble-free erection. They are easy to roll-in, and provide maximum tightness in the tube sheets.

UNIFORMITY . . . ELECTRUNITE Pressure Tubes are uniform in grain structure, have predictable rolling-in characteristics . . . no slivers, hard spots, or scabs to cause costly delays. Wall thicknesses are uniform, tubes are fully concentric, tube strength is uniformly high.

Let us send you a copy of Bulletin BT-12 . . . it describes ELECTRUNITE Pressure Tubes for boilers and process equipment.

REPUBLIC STEEL CORPORATION
STEEL AND TUBES DIVISION
224 EAST 131st STREET
CLEVELAND 8, OHIO

REPUBLIC STEEL

ELECTRUNITE

Use the C_Q Method—

Evaluate All The Quality Factors
IN SELECTING CONTROL VALVES

"Quality" is only a word—which has no real number or scale; but, by definition, it implies comparison and by common usage it connotes high value.

The C_Q (Quality Coefficient) method sets a standard — which is necessarily also intangible but one which could, if you wished, be given an arbitrary numerical expression.

Our standard of design and manufacture is to build a control valve which, in the light of our extensive knowledge and experience, will live up to our definition of quality, i. e.:

"A high quality product provides accurate performance over a long period with a minimum of maintenance and operation delays."

Your standard in selecting control valves is undoubtedly very similar, based on your own experience.

We suggest your using the C_Q method in comparing control valves. Set a standard; evaluate *all* the quality factors in the valves considered. (As a reminder, a list of some of these is printed here.) The sum of all quality factors of a valve is its C_Q (Quality Coefficient). Then when you compare price, consider that the invoice figure is only the first cost — the real cost might be expressed

$$\text{Real Cost} = \frac{\text{Price}}{C_Q}$$

for you will agree that for the same investment, the higher the quality the lower the actual over-all cost.

Compare Masoneilan Control Valves with *any* others — use the C_Q Method.

Check For These Diaphragm Motor Quality Factors

Performance Factor
Effective Diaphragm Area
Stroke Length
Response to Air Pressure Changes
Stroke vs. Air Pressure Relationship
Guide Design for Minimum Friction

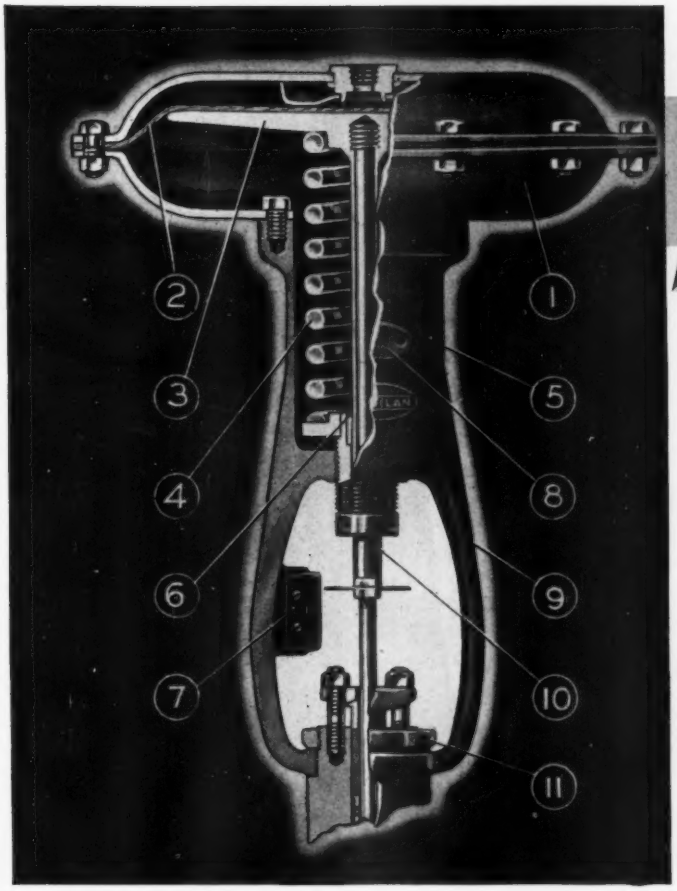
Mechanical Construction Factor
Diaphragm Case Air Pressure Rating
Diaphragm Case to Yoke Fastening
Rigidity and Strength of Yoke
Yoke Connection to Body Assembly
Strength of Spring Stem and Diaphragm Button Assembly
Size of Springs vs. Effective Area and Stroke of Motor
Diaphragm Design for Reproducible Stroke
Motor Guiding for Friction Free Operation

Convenience Factor
Provision for Mounting Instruments and/or Accessories
Adaptability to Air-to-Close or Air-to-Open Action
Provision for Various Types of Handwheels
Selection of Stroke and Spring Range

Maintenance Factor
Accessibility of Valve Stuffing Box
Convenience of Spring Adjustment

Appearance Factor
Low Over-all Height
Smooth External Contours
Compactness
Serial Plate Information
Travel Indicator Design
Ability to Withstand Rough Handling
Strength of Stem and Stem Connections
Protection of Spring and Diaphragm

See our Exhibit in Booths 214-216 at the Sixth National Instrument



For Example Consider the Diaphragm Motor of Masoneilan 10,000 Series Control Valves

1. **Steel Diaphragm Case** for high mechanical strength, lightness, high safety factor in case of severe over-pressuring. Parkerized inside and out for corrosion resistance. ¼" or ½" air connection fitting welded inside case for better appearance. Initial stop inside case establishes correct stroke with respect to diaphragm position. Through bolted construction for ease of disassembly — avoids moisture-collecting pockets which cause rusting. Permits use of flat stock diaphragms in emergency. Adapted to case-mounted handwheels. Provides for reverse-acting motors for valves with non-reversible plugs.

2. **Preformed Diaphragm** of rubber or neoprene with fabric insert — designed to provide maximum practical effective area throughout stroke. Provides frictionless self-aligning upper guide. Beaded edge adds insurance against leakage.

3. **Steel Diaphragm Button** — compact and strong — welded to spring stem, preventing possibility of disengagement in the event of excess line vibration.

4. **Heavy Springs** for low stress — prevents breakage and permanent set. Calibrated for 3-15 or 6-30 psi ranges. Japanned for corrosion resistance. Exterior adjustment for ease of setting spring initial — has ball thrust bearing on larger size valves.

5. **Cast Iron Yoke and Spring Barrel** have heavy cross-sections for rigidity and mechanical strength; will not deform in rough handling, causing misalignment. Inherently corrosion resistant. Inclosed spring barrel protects springs. Unusually large opening in yoke provides ease of access to stuffing box and positioner linkage — makes stroke scale easily readable. Yoke designed for side mounted handwheels.

6. **Oilite Bronze Lower Guide** together with self-aligning frictionless upper guide in diaphragm insures alignment, minimum friction.

7. **Stroke Scale** graduated in ⅛" of actual travel. Rated stroke marked on plate. Indicator index always at same position on spring stem — aids in stem adjustment on assembly.

8. **Mounting Pads** — front and rear, provide for mounting controller, positioner and/or air set.

9. **Serial Plate** has *full* valve specifications — materials, rating, spring range, direction of travel — even an etched picture of type and seating direction of plug.

10. **Large Diameter Spring Stems** for strength; direct threaded connection to valve stem without use of adapters; plus Keylock on sizes 3" up.

11. **Motor to Bonnet Connection** by means of heavy, large diameter, forged steel drive nut, for strength and true alignment.

THE MASONEILAN 10,000 SERIES CONTROL VALVE IS

A High C_Q Product

MASON-NEILAN REGULATOR CO.

1185 Adams Street, Boston 24, Mass., U. S. A.

Sales Offices or Distributors in the Following Cities

New York • Syracuse • Chicago • St. Louis • Tulsa
Philadelphia • Houston • Pittsburgh • Atlanta • Cleveland
Cincinnati • Detroit • San Francisco • Salt Lake City • El Paso
Boise • Albuquerque • Charlotte, N.C. • Los Angeles
Denver • Appleton, Wisconsin • Corpus Christi • New Orleans
Mason-Neilan Regulator Co., Ltd., Montreal and Toronto

YOU CANNOT INSURE FULL C_V WITHOUT A HIGH C_Q

Exhibit, Sam Houston Coliseum, Houston, Texas, September 10-14, 1951

for maximum footage ... drill soft formations with

TYPE ES SERIES BITS

TYPE ES SERIES Three Cone Rock Bits are not only drill in the soft formations with a high penetration rate, but are safe to use in the harder formations. shales, anhydrite, soft limestones, and broken formations where occasional hard streaks are interspersed with softer rock.

The sturdy teeth, with a substantial bearing, permit safe use of heavy The angle of rotation and cone combine to give the sliding, tearing action essential for lightweight drilling.

CP Rock Bits are furnished in types and sizes to meet the specific drilling requirements of different oil fields. Prompt service is assured in the Mid-Continent, Rocky Mountain and Canadian fields.

CHICAGO PNEUMATIC TOOL COMPANY

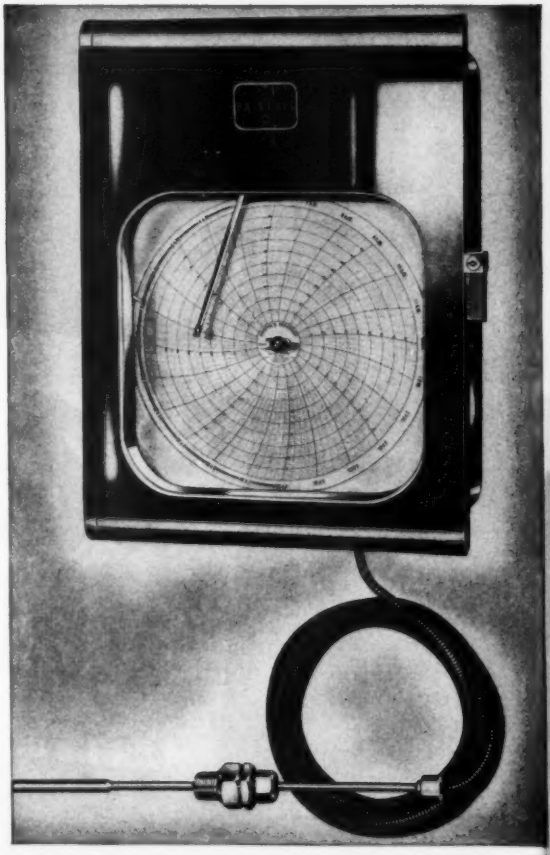
MANUFACTURED AT FRANKLIN, PA.

GENERAL OFFICES: 6 EAST 44th STREET, NEW YORK 17, N. Y.

Oil Tool Division Office: One N. W. 16th Street, Oklahoma City, Oklahoma

In Canada: 10103 81st Avenue, So. Edmonton, Alberta, Canada • In Mexico: Mexico, D. F., Rosas Moreno No. 41, Tampico, Tamps., Apartado No. 174
Special Oil Tool Export Agent: E. F. Gahan, Inc., 500 Fifth Ave., New York 17, N. Y. (West Indies, Central and South America, exclusive of Mexico)

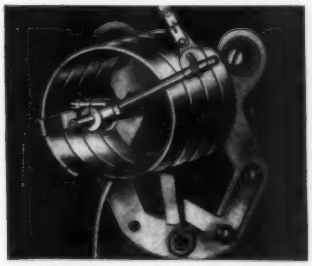
NEW SERIES 500 RECORDING THERMOMETER CARRIES ON THE BRISTOL TRADITION



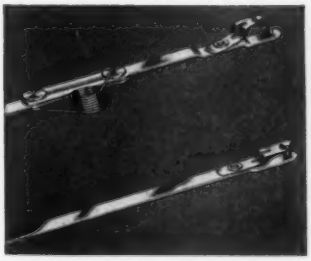
The Bristol Series 500 Recording Thermometer for temperatures between minus 125 F and 1000 F incorporates every modern improvement for dependable accuracy, ease of use and convenient servicing.

In addition, it represents all the wealth of thermometer "know-how" gained by nearly 60 years of experience in building hundreds of thousands of recording thermometers—known all over the world for their high accuracy and dependability.

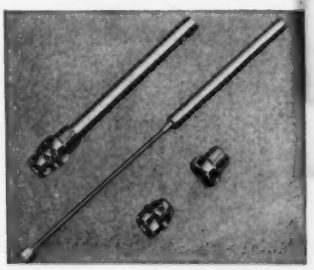
Send for the new Thermometer Catalog T840. Address THE BRISTOL COMPANY, 120 Bristol Road, Waterbury 20, Conn.



MORE SECURELY SEALED—TROUBLE-FREE—The measuring system is securely sealed against leakage. Parts are joined with silver solder by induction heating.



STURDY, FRICTION-FREE CONNECTION between measuring element and pen arm mechanism is provided by strong, adjustable links with polished stainless steel pins.

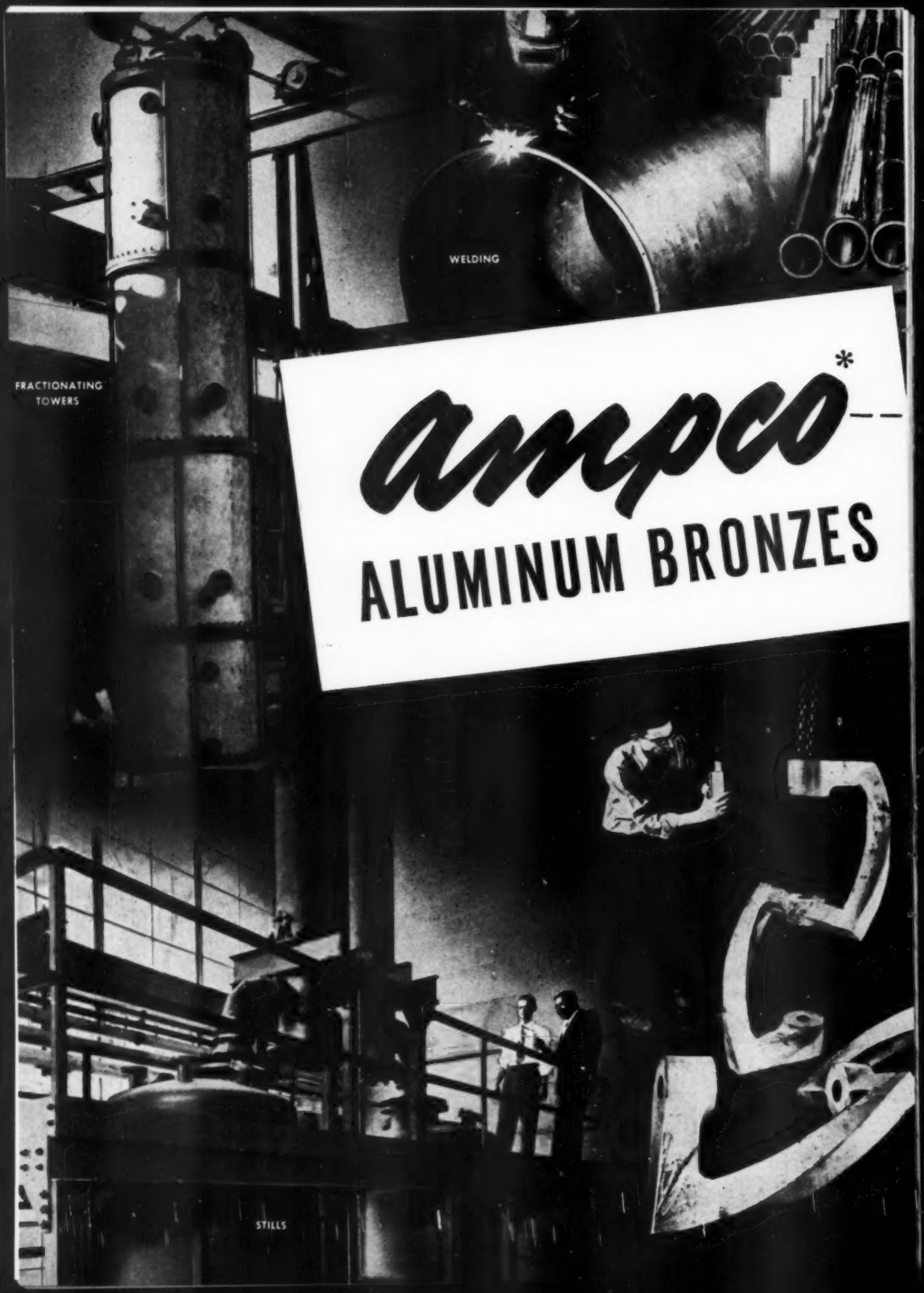


FLEXIBLE ARMOR is interlock-type, withstands heaviest abuse. *Bulbs*—plain, union or socket type—easily converted.

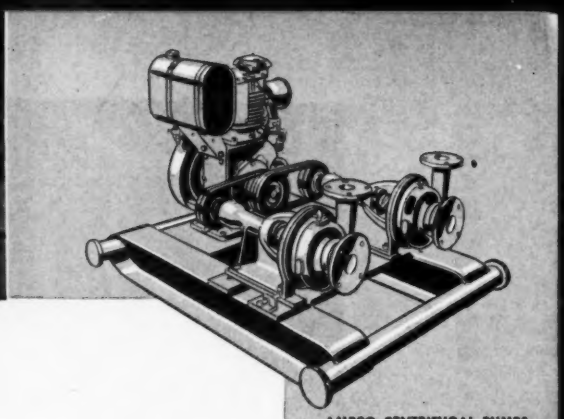
THE DEPENDABLE GUIDEPOST OF INDUSTRY

BRISTOL

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

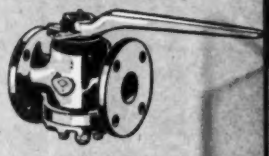

WELDING
FRACTIONATING TOWERS
ampco*--
ALUMINUM BRONZES
STILLS

PIPE

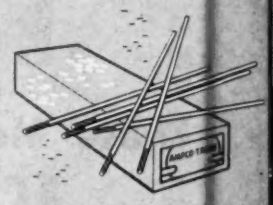


AMPCO CENTRIFUGAL PUMPS

----an answer to corrosion problems!



AMPCO PLUG VALVES



AMPCO BRONZE ELECTRODES

AMPCO PIPE FITTINGS

Boiler Code Approval

Ampco Metal Grade 8 is an annealed alpha aluminum-bronze alloy conforming to ASTM B-169-50T Alloy D. It is approved for use in the construction of unfired pressure vessels. See your Boiler Code Handbook — paragraphs U-68 and U-69 as interpreted in case No. 1108 — for complete details.

Tear out this coupon and mail today!

*Reg. U. S. Pat. Off.

Ampco Metal, Inc.
Milwaukee 46, Wisconsin
West Coast Plant
Burbank, California

AMPCO

AGITATORS

AMPCO METAL, INC., Dept. OG-9, Milwaukee 46, Wis.
Send me information on the application of Ampco Aluminum Bronzes for corrosion-resistant service in the Process Industries.

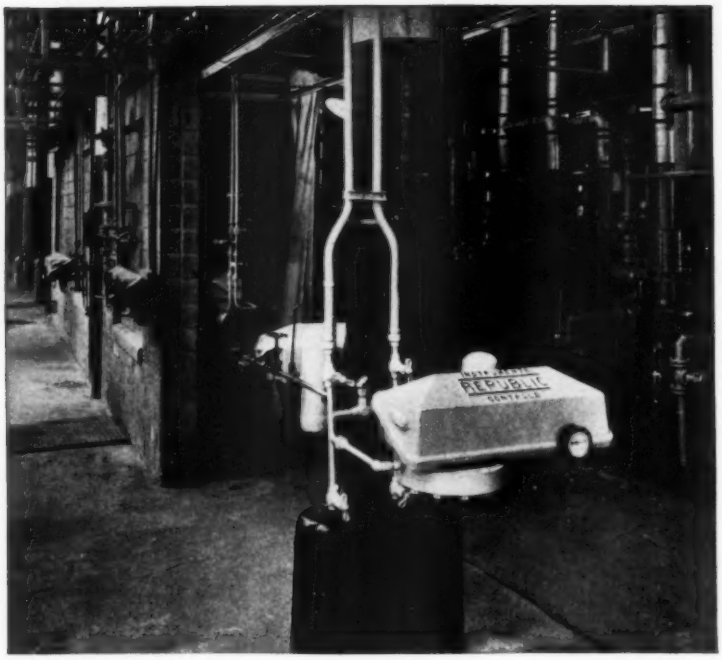
Name..... Title.....

Company.....

Company Address.....

City..... (.....) State.....

PR-4



These Meters Had To Be
ACCURATE — FLEXIBLE — RUGGED

One hundred twenty one Republic Pneumatic Transmitters are measuring the flow and level of various acids in a large chemical processing plant, a section of which is pictured above.

These transmitters have a guaranteed accuracy of within ½ of 1% of the transmitter range. By making a few minor adjustments or substituting a few small parts, their operation can be easily changed to any desired range between a minimum of 0—0.6" of water to a maximum of 0—704" of water. Their construction is more like that of a precision machine than of the sensitive instrument they are. It is for these reasons that Republic Pneumatic Transmitters, even though comparatively new, have already been specified and installed on over 2500 industrial metering applications.

Republic Pnuematic Transmitters are available for measuring flow, liquid level, pressure or liquid density of a wide range of fluids. They employ the force-balance principle to convert these process variables into air pressures which vary proportionally. These air pressures become direct measurements and can be conducted to reading instruments or used as the measuring impulse for the actuation of an automatic controller.

Data Book No. 1001 contains complete details on the construction and operation of Republic Transmitters. Write for your copy today.

REPUBLIC FLOW METERS CO.
2240 Diversey Parkway, Chicago 47, Illinois

WELDOLETS

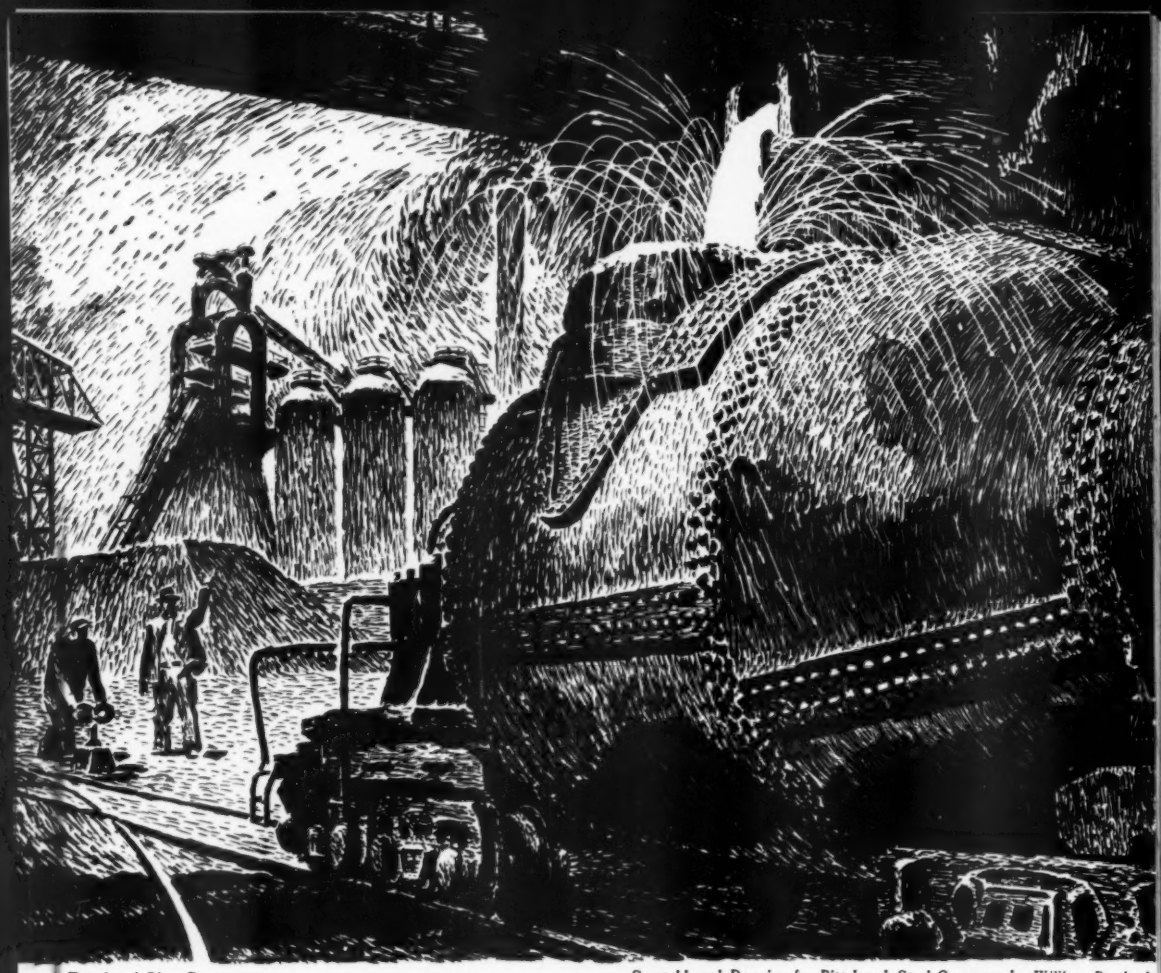
WELDING FITTINGS FOR ANY PIPING SERVICE

NATURAL GAS COMPRESSOR STATION PIPING CONSTRUCTED ECONOMICALLY AND EFFICIENTLY USING WELDOLET WELDING FITTINGS THROUGHOUT

This installation, together with a number of important applications of Weldolet Welding Fittings in various types of service is shown in the new Bonney Vol. 3 Weldolet Catalog.

The completely new Bonney catalog will furnish descriptive, dimensional information and installation instructions. The technical section demonstrates graphically how Weldolet Welding fittings offer the quickest, safest and most economical method of establishing and maintaining 100% pipe strength at branch connections in accordance with code requirements.

BONNEY FORGE & TOOL WORKS



Tapping A Blast Furnace — *Scratchboard Drawing for Pittsburgh Steel Company by William Pendred*

Progress in Steel

Later this year a greatly swollen stream of steel products will flow from Pittsburgh Steel Company's works and into the channels of American industry. This quickening flood will be the result of an expansion program that represents a fifty percent increase in capacity for Pittsburgh Steel—an extra half-million tons of vital metal per year.

A few months ago, as a part of its planned Program of Progress, management at Pittsburgh Steel decided to expand its production of steel wire and seamless steel tubular items—also to add a new line of steel sheet and strip.

In order to do this, provision had to be made to produce more iron. This is being done by increasing blast furnace efficiency. Soon increasing streams of iron, stemming from these roaring furnaces, will help fill the newly expanded open-hearth furnaces. There it will be changed, by further processing, into steel. Then it will go on through rolling and finishing mills, which are also being expanded, to become quality wire and tubular products—strip and sheet—to serve all industry and the armed forces.

This Program of Progress at Pittsburgh Steel is a part of the industry-wide expansion plan which will add millions of tons of steel capacity to the might of the nation. It exemplifies the determination of the industry to be prepared and ready to face the greatest demand for steel for defense and peacetime needs the world has ever known.

Pittsburgh Steel Company

Pittsburgh, Pennsylvania

It's the Nash!

There are no mechanical complications in a Nash Compressor. A single moving element, a round rotor, with shrouded blades, forming a series of buckets, revolves freely in an elliptical casing containing any low viscosity liquid. This liquid, carried with the rotor, follows the elliptical contour of the casing.

The moving liquid therefore recedes from the rotor buckets at the wide part of the ellipse, permitting the buckets to fill with gas from the stationary Inlet Ports. As the casing narrows, the liquid is forced back into the rotor buckets, compressing the gas, and delivering it through the fixed Outlet Ports.

Nash Compressors produce 75 lbs. pressure in a single stage, with capacities to 6 million cu. ft. per day in a single structure. Since compression is secured by an entirely different principle, gas pumping problems difficult with ordinary pumps are often handled easily in a Nash.

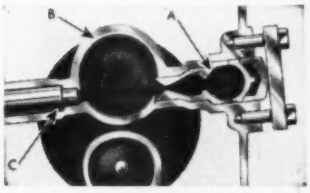
Nash simplicity means low maintenance cost, with original pump performance constant over long periods. Data on these pumps sent immediately on request.

- No internal wearing parts.
- No valves, pistons, or vanes.
- No internal lubrication.
- Low maintenance cost.
- Saves floor space.
- Desired delivery temperature automatically maintained.
- Slugs of liquid entering pump will do no harm.
- 75 pounds in a single stage.

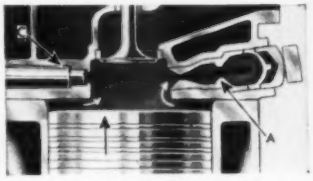
NASH ENGINEERING COMPANY
322 WILSON, SO. NORWALK, CONN.

CONTINENTAL MOTORS
Powerful as the Nation
AMERICA'S STANDARD

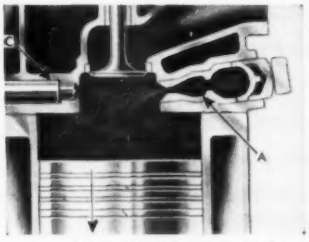
Here's the "Inside Story" of
CONTINENTAL CUSHIONED POWER



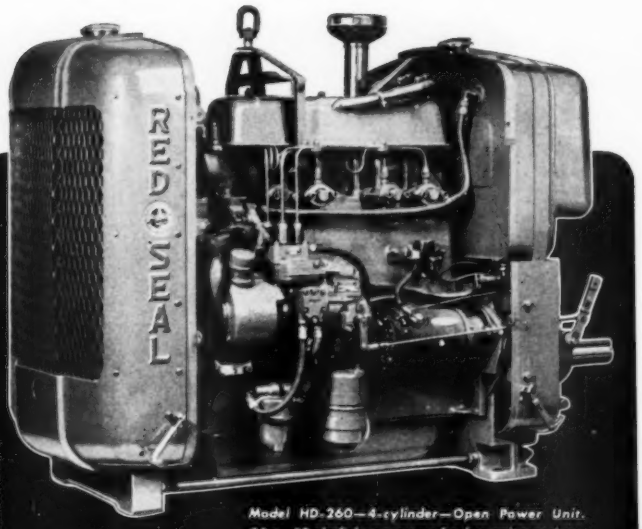
Top view of combustion chamber, showing Dyna-Cell (A), turbulence chamber (B) and nozzle (C). A definite portion of fuel charge from nozzle enters Dyna-Cell.



Fuel charge is self-ignited by pressure just before piston reaches top of compression stroke. But pressure developed by the fuel within the Dyna-Cell is absorbed momentarily by the latter . . . .



. . . to be released through metered opening during the piston's downstroke. Thus, peak pressures are converted into useful "follow-through" power.



Model HD-260—4-cylinder—Open Power Unit.
25 to 50 shaft horsepower for intermittent duty.
20 to 40 shaft horsepower for continuous duty.

RED SEAL CUSHIONED POWER DIESELS COST LESS TO RUN AND TO MAINTAIN

Continental Cushioned Power Combustion Chamber with Dyna-Cell (see diagrams at left) not only gets ALL the power from the fuel, but smooths and prolongs the power impulse, preventing the development of destructive peak pressures usual in engines of Diesel type. This avoidance of extreme pressures lengthens engine life. It speeds and simplifies service, by permitting wide interchangeability of parts between Red Seal Diesel and gasoline models. Moreover, the weight-to-horsepower ratio is unusually favorable, a consideration of great importance in many applications. Choose Continental Cushioned Power Diesels for lower costs . . . longer useful life.

REMEMBER, GOOD EQUIPMENT IS BETTER WITH CONTINENTAL RED SEAL POWER

Continental Motors Corporation
MUSKEGON, MICHIGAN

6218 CEDAR SPRINGS ROAD, DALLAS 9, TEXAS . . . 3817 S. SANTA FE AVE., LOS ANGELES 58, CALIF.

Be sure with Pure

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THE PURE OIL COMPANY

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General Offices, Chicago, Illinois

Up to 22 times

more operations without re-lubricating

HOMESTEAD-REISER

Self-Sealed

LUBRICATED PLUG

VALVES

TEST RECORD

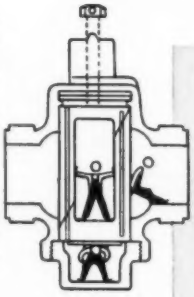
VALVE	NO. OF OPERATIONS Without RE-LUBRICATING
VALVE "A"	5
VALVE "B"	33
HOMESTEAD-REISER VALVE	**110**

Each valve assembled with the manufacturer's recommended lubricant. Test made on 75 lb. air pressure.

This comparative test of a Homestead-Reiser Valve and two other well-known lubricated plug valves showed that the Homestead-Reiser Valve remained drop-tight through twenty-two times more operations than Valve "A" without re-lubricating, and through three times as many operations as Valve "B". That means that Homestead-Reisers require less attention, and give greater economy of lubricant.

Prove the superiority of Homestead-Reiser Valves to your own satisfaction, by installing a few in your plant, side by side with any other lubricated plug valve. They may be had in both semi-steel and cast-steel, sizes $\frac{1}{2}$" to 12" for steam working pressures to 150 pounds, or oil-water-gas to 200 pounds.

Write for new catalog 39-5, and for prices on your requirements.



"Self-Sealed" MEANS

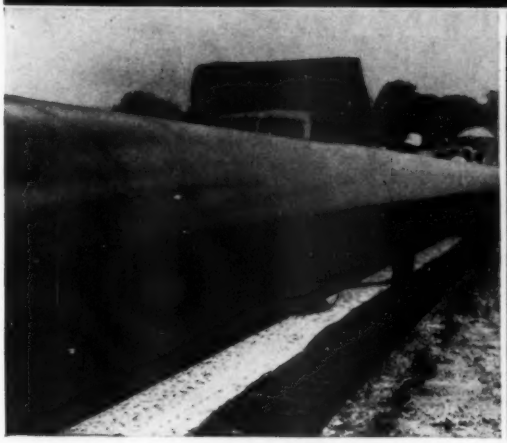
. . . that in addition to a full-port lubricant seal, the wedge-action of the plug under line pressure forces the finished surfaces of the plug outward, and constantly presses them against the seating surfaces of the body, thus keeping them always in intimate contact. The plug automatically adjusts itself for wear, assuring extra long life, maximum leakless service, and lubricant economy.

HOMESTEAD VALVE MANUFACTURING CO.

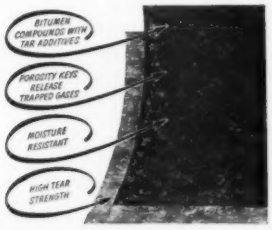
"Serving Since 1892"

P. O. Box 403 Coraopolis, Pa.

WHO PAYS for the HIGH COST of CONTRACTORS' HARD LUCK?



In Fiberglas Parallel Reinforced COROMAT* Outer Wrap you see finer fibers and more of them, distributed the Fiberglas Way. This means *controlled porosity* . . . uniform bleed-through . . . even *coating* and *positive integration* of coating and wrap . . . an end to the time-wasting jeep problem. Parallel reinforcement gives *strength* for low-cost, all-day, break-free wrapping.



Hold Fiberglas Outer Wrap to the light and see the even pattern of pores, to key the wrap *permanently* to the coating—no stripping! Made on a sealed-in COROMAT core, this wrap is tough, for all-day break-free application. It *won't wick out* the rich, protective fractions of the coating or the wrap itself. Inorganic, *it can't rot.*

PIPE-LINE CONTRACTORS can't take excessive jeeps and breaks, the penalties for poor penetration, for very long. And it's the specifier who is blamed for these and other excessively high costs.

That's why the Fiberglas* claim of better pipe wrap know-how makes sense to contractor and specifier alike. Better know-how hangs up such records as, "40 per cent MORE MILEAGE WITH THE SAME CREW"; "NO BREAKS ALL DAY"; "A FEW JEEPS WHERE THERE HAD BEEN DOZENS".

Fiberglas wraps mean the best job at the lowest applied cost, for Fiberglas means the longest glass wrap experience, the best research, and DELIVERY when and where wanted. Why not have the best, at the lowest cost? . . . OWENS-CORNING FIBERGLAS CORPORATION, Dept. 54-G4, Toledo 1, Ohio. Branches and Warehouse Stocks in Principal Cities, to Serve You.

OWENS-CORNING
FIBERGLAS

*Fiberglas (Reg. U. S. Pat. Off.) and Coromat are trade-marks of Owens-Corning Fiberglas Corporation

FIBERGLAS IS IN YOUR LIFE...FOR GOOD!

CAPACITY... PORTABILITY *plus* WAUKESHA POWER

● High capacity on wheels . . . Waukesha-powered . . . and so light in weight that it can go anywhere! That's the *Failing* "2500" Holemaster Drill. It's made by those pioneers in portables, the Geo. E. Failing Supply Company of Enid, Okla. They designed it to handle a 30,000-lb. drill pipe load and it is conservatively rated to drill to 2500 ft., using a 2⅞-in. drill pipe or 4000 ft. with 2⅜-in. pipe.

Because of their proved drilling dependability, the power units are two six-cylinder Model 6-MZAU Waukeshas. Either or both may drive the double-drum drawworks and rotary, or the 5½-in. x 8-in. reciprocating slush pump; both may be compounded to drive complete drill unit.

Helical gear transmission gives four speeds forward and one reverse. A two-plate 14-in. master clutch is ahead of transmission. Hydraulic take-off on each power unit incorporates a fluid coupling and mechanical friction clutch. This hydraulic cushion drive absorbs mechanical shock and gives remarkable over-all flexibility. For the greatest degree of portability—pick a portable powered with Waukesha. Send for Bulletin 1408.

127

WAUKESHA 6-MZAU OIL FIELD POWER UNITS

6 cylinders, 4¼-in. bore x 4¾-in. stroke, 404 cu. in. displacement.

•

WAUKESHA MOTOR COMPANY

WAUKESHA, WISCONSIN

NEW YORK, TULSA, LOS ANGELES

a straight line to a better product

—a new one or a modernized old one—

CLARK works with the engineers of many companies in designing and building special drive units for agricultural and industrial machinery.

PRODUCTS OF CLARK—TRANSMISSIONS • AXLES • AXLE HOUSINGS • TRACTOR DRIVE UNITS • FORK TRUCKS AND TRACTORS
POWERED HAND TRUCKS • GEARS AND FORGINGS • ELECTRIC STEEL CASTINGS • RAILWAY CAR TRUCKS

CLARK EQUIPMENT COMPANY • BUCHANAN, MICHIGAN
Other Plants: BATTLE CREEK *and* JACKSON, MICHIGAN

IT'S PACKED WITH SATISFACTION WHEN IT'S PACKED WITH R/M

The Raybestos-Manhattan packings in the stuffing box of this hydraulic accumulator ram play an important part in the machine's successful operation. The complete line of R/M packings and gaskets plays an important part in the successful operation of valves, compressors, pumps, hydraulic and other equipment of all types. The R/M distributor near you will gladly help select the right R/M packing or gasket to meet your needs. Or write for the new R/M Packing Catalog.

R/M PACKINGS

RAYBESTOS-MANHATTAN, INC.

PACKING DIVISION, MANHEIM, PA.

FACTORIES: Bridgeport, Conn. Manheim, Pa.
No. Charleston, S.C. Passaic, N.J.

RAYBESTOS-MANHATTAN, INC., Manufacturers of Packings · Asbestos Textiles · Mechanical Rubber Products · Abrasive and Diamond Wheels · Rubber Covered Equipment · Brake Linings · Brake Blocks · Clutch Facings · Fan Belts Radiator Hose · Powdered Metal Products · Bowling Balls

COMPACT... EFFICIENT

PARKERSBURG'S unitized separators are easy to install, require minimum foundation and have all of these superior performance features of the famous Type "S" Horizontal Separators:

No. 5114

- **15 to 20% greater facility for primary separation**
- **Faster discharge of gas-free oil; longer retention of more gaseous liquids.**
- **Incoming fluid broken into largest possible droplets**
- **All entrained liquid removed from gas stream**
- **Skimmer pipe provides additional scrubbing**
- **No-Bleed level controller maintains liquid at any desired level to provide maximum space for gas travel and natural separation.**

PARKERSBURG RIG & REEL COMPANY—Parkersburg, West Va.

• Ask your Parkersburg Representative for complete details about this and other Parkersburg Horizontal Separators.

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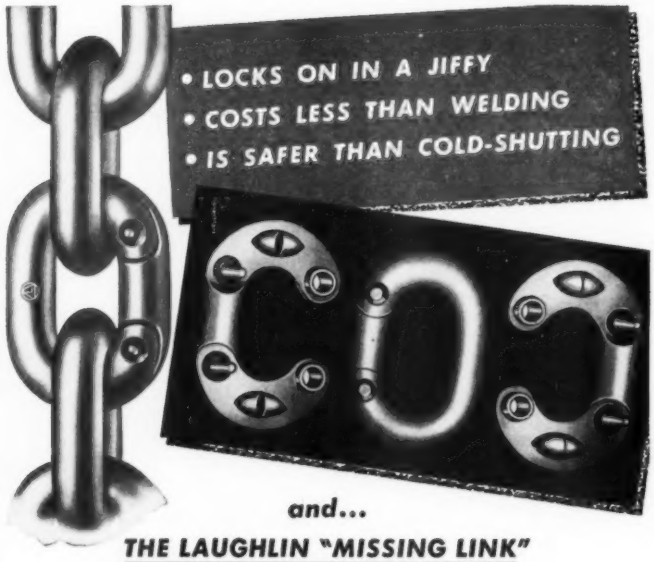
PRESSURE EQUIPMENT

HORIZONTAL AND VERTICAL SEPARATORS • HYRECO • HYDRACEPTER • SCRUBBERS • TREATERS • HEATERS

Manufactured in Houston, Texas



and...

THE LAUGHLIN "MISSING LINK"
WITH INTERLOCKING SAFETY LUGS

Makes Your Chain Stronger Than Ever!

To attach a "Missing Link" you simply insert the halves through the links to be joined, fit the rivets into the rivet holes, then peen the rivets to fill the countersunk holes. And once on, the pressure-matched *interlocking lugs* take all the load — with no strain on the rivets.

Add the fact that drop-forged, heat-treated "Missing Links" are *made* stronger than proof coil chain to begin with, and you'll see why these time- and money-saving repair links give you a stronger, safer chain than you ever had before! . . . Laughlin "Missing Links" are available in all sizes from 3/16" to 1⅞" at your mine, mill or oil field supply house.

Free! *Catalog-Data Book*

Tells you how to select the *right* wire rope and chain fitting for every job. Complete specifications — helpful tables. Use the coupon below.

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LAUGHLIN

THE MOST COMPLETE LINE OF DROP-FORGED WIRE ROPE AND CHAIN FITTINGS

They Say—

New Concept of Justice

"The Federal Trade Commission has the job of policing the laws regarding business pricing and competition. Sometimes the FTC notes that the price of widgets manufactured by two different companies is the same, and it suspects there has been a heinous crime committed, a conspiracy to fix the price, a conspiracy for which, under the law, the men involved can be put in jail.

"There is a bill now pending in Congress designed to make it clear that a businessman can cut his prices in good faith to meet the low prices of competitors. It would make it clear that similarity in prices is not in itself prima facie evidence of a heinous crime; the FTC would have to prove an actual combination or conspiracy.

"So FTC Commissioner Stephen J. Spingarn went before a committee and testified against the bill. Among other things, he said, of the Senate version of the bill, that it would put the burden of the proof on the Government, instead of on the people charged with the crime. And this is supposed to be a terrible thing!

"In other words, the FTC doesn't think it ought to have the burden of proving its charge. It ought to just be able to make the charge. And if the men charged can't prove they didn't do it, they are guilty and can be fined, or even put in jail."

Editorial in the Wall Street Journal.

No Lack in Our Time

"We can see sufficient raw material in one form or another to supply all the gasoline requirements for a thousand years or so."

Charles S. Jones, president, Richfield Oil Corp., addressing Los Angeles Society of Security Analysts.

Iranian Opportunity

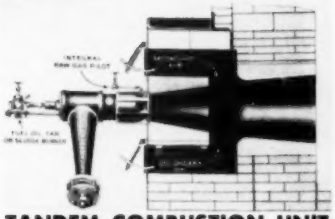
"There is the anachronism of the British Labor Government, which has itself nationalized Britain's coal mines, railway lines, gas and electricity works and its steel industry, playing the role of champion of a company which is marked as the victim of a similar nationalization effort on the part of the Iranian Government. Now for the first time, national interest has proved stronger than doctrinaire economic theory.

"Still, it would not be altogether surprising if some young Iranian with an Oxford or Cambridge degree would produce a brief in favor of nationalization, liberally garnished with excerpts from the campaign speeches

Ten Thousand Hours Without Shutdown is Not "OVERTIME"

. . . for process oil heaters fired by the NATIONAL AIROIL TANDEM COMBUSTION SYSTEM firing dirty, wet refinery gas; uncut asphalt; refinery fuel oils . . . HOURS ARE LONG . . . PROFITS ARE HIGH . . . YOU will realize high profits from YOUR heaters when TANDEM COMBUSTION UNITS are specified.

Detailed information sent upon request on your business letterhead.



TANDEM COMBUSTION UNIT

— CHEMICAL-PETROLEUM DIVISION —

NATIONAL AIROIL BURNER CO., INC.

Main Offices & Factory: 1239 EAST SEDGLEY AVENUE, PHILADELPHIA 34, PA.

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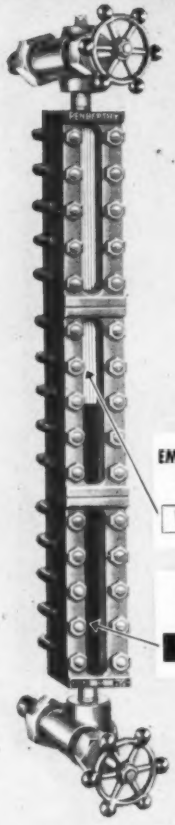
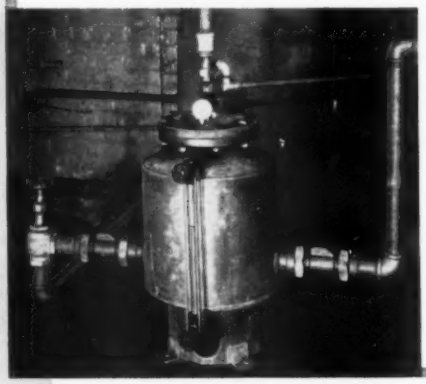
PENBERTHY PRODUCTS THAT improve PROCESS AND PLANT

PENBERTHY REFLEX LIQUID LEVEL GAGES



You can't misread the Penberthy Reflex Liquid Level Gage . . . *it prevents mistakes.* Due to a simple, invariable optical principle, the empty space always shows white . . . the liquid black. In addition to standard units, Penberthy Reflex Gages are fabricated to customers' specifications from special alloys to meet unusual corrosive, pressure and temperature conditions. Write for new Catalog No. 35.

PENBERTHY CYCLING JET PUMPS



Operated by air, gas, or steam pressure, pumps (without clogging) any liquid that will flow through pipes. Lifts fluid from lower level and discharges against pressure approximately equal to operating gas pressure. Operates automatically by ejector that exhausts the vessel . . . drawing in liquid . . . then gas pressure pushes it out. Ejector and its control valve not in contact with fluid pumped. Corrosion proofing easy. Write for Bulletin 5030.

PENBERTHY EJECTORS

A simple jet pump operated by air, water or steam. Has no moving parts . . . needs no lubrication. Will not get out of order . . . wear is not appreciable. Reliable, noiseless, compact, convenient and initial cost is very low. Made in bronze, iron and wide variety of materials that successfully withstand corrosion, contamination and high temperatures. Special units developed to meet unusual conditions. Write for Catalog 34.

PENBERTHY *Explosion Proof* SUMP PUMPS

Motor and switch totally enclosed, this pump has Underwriters approval for Class I, Group D, and Class II, Groups E, F and G hazardous locations. These include gasoline, solvent vapors, metal dust, natural gas, carbon black, naphtha, alcohol, grain dust, acetone, lacquer, coal and coke dust, etc. Made of copper and bronze throughout, this pump is corrosion proof, durable, thoroughly dependable. Write for Bulletin 4929.

PENBERTHY INJECTOR COMPANY

DETROIT 2, MICHIGAN

Established 1886 *Canadian Plant, Windsor, Ontario*

of Mr. Attlee, Mr. Morrison, and other British Labor Party leaders."

William Henry Chamberlin, writing in the Wall Street Journal.

Pat for PAD

"PAD's responsibilities are big and broad. They have to do with all phases of petroleum and its products. But its policy is consistently and simply stated: Issue only such controls on the industry as are absolutely necessary. Relax or remove such controls at the earliest possible moment. Keep the petroleum industry as free as possible for the free tomorrow for which all of us live and work.

"It's a program, it seems to me, that follows the best of American tradition."

Charles Morrow Wilson, writing in Service, Cities Service Co.

Don't Baby Iran

"The belief that the United States will rescue the Iranians from the predicament they got themselves into is apparently strong, but it is surely incorrect. There is a right and wrong in this case and also a question of precedent that is most dangerous not only to the international oil industry but to the process of private foreign investments anywhere."

Editorial in the New York Times.

King Size and Growing

"While the chemical industry as a whole doubled its plant from 1939 to 1949, private investment in petrochemical factories has increased possibly tenfold since World War II.

"No one knows for sure how big petrochemistry is now; statistics can't keep up with its rapid expansion. But already it touches every American's daily life. Today petrochemistry is recognized as one of our prime industries, for defense as well as for peace. During the next half century, its influence on America's way of living, and possibly on the nation's very survival, promises to be immense."

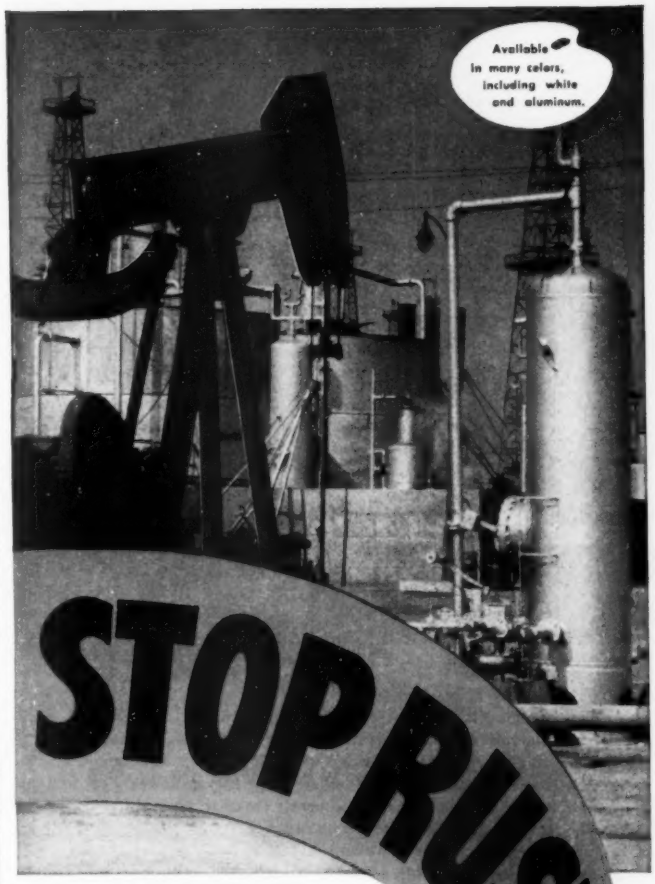
The Lamp, Standard Oil Co. (N. J.).

Keep It Flowing

"It is significant to note that while Pennsylvania Grade crude-oil production is less than 1 per cent of the United States total, it accounts for 12 per cent of the motor oils consumed in the country. No more adequate proof should be needed of the importance of this oil to the nation's economy and security.

"Production of Pennsylvania crude currently averages 51,000 bbl. daily, coming from 129,000 wells owned by 14,000 operators. . . .

"Any reduction in the output of this much needed petroleum because of a lack of sufficient tubular goods would be a severe blow not only to the economy of the region, but to the



Save Metal with
RUST-OLEUM

Silently, but ruthlessly (even as you are reading this) rust is gnawing away at your tanks, pumps, derricks, refining equipment, buildings, roofs, fences—every rustable metal—inside and outdoors.

To protect your investment—to keep every possible pound of new steel for the defense program—*adopt rust control with Rust-Oleum as an important part of your maintenance program.*

RUST-OLEUM stops rust. It can be applied *even* over rusted surfaces. It is not necessary to remove all the rust. Just use wire brush and sharp scraper to remove rust scale and loose rust.

RUST-OLEUM can be obtained promptly from Industrial Distributors' stocks in principal cities of the United States and Canada. Write on your company's letterhead for complete catalog and nearest source of supply.

RUST-OLEUM CORPORATION
2541 Oakton Street, Evanston, Illinois

• Stocked and Sold by Leading Industrial Distributors in All Principal Cities of the United States and Canada

meet the newest member of the *FarriSeal* family

BalanSeal*

IT SAVED $75,000 IN PIPING WITH A $5,000 VALVE INVESTMENT**

Pioneered by Farris Engineering Corp., embodying advanced engineering technics, *and absolutely unique*—although it is now being imitated—the patented BalanSeal is ideally suited for use wherever a collecting system is required for a series of safety-relief valves. It permits a higher downstream pressure—and consequently, smaller piping. Yes! The cost of a BalanSeal valve installation is a mere fraction of the savings effected in down-stream piping. (**In one case, a cost reduction of $75,000 resulted from a $5,000 investment in BalanSeal Valves.)

In BalanSeal, the sole force opposing the opening of the valve is the spring. Downstream back pressure, static or surge, cannot act on the disc and has absolutely no effect on the relieving point.

BalanSeal is the ultimate in safety-relief valve design and construction. The bellows, which also distinguishes the FarriSeal design, is so proportioned as to eliminate any unbalanced forces on the valve disc—which is perfectly balanced on its seat at the set pressure. Like all other FarriSeal Valves, perfect protection is provided for guide, stem and spring by completely isolating these parts from the lading fluid.

Get the facts on the revolutionary BalanSeal Safety Relief Valve. Find out how you can cut installation costs to the bone, step up operating profits. Write for Bulletin No. 52B—it will pay off in ASSURED safety and installation economy.

*Patented and Patents Pending

Farris

SAFETY and RELIEF VALVES

FARRIS ENGINEERING CORP.

412 Commercial Avenue Palisades Park, N. J.

7676

national economy and security as well."

Editorial in the Oil City Derrick.

CALENDAR

July

Wyoming Geological Association, sixth annual field conference, Rawlins, Wyo., July 31-August 3.

August

Wyoming Geological Association, sixth annual field conference, Sinclair, Wyo., August 1-3.

Society of Automotive Engineers, Inc., West Coast meeting, Olympic Hotel, Seattle, August 13-15.

Western Petroleum Refiners Association, regional meeting, Leonard Refineries Auditorium, Alma, Mich., August 17.

American Institute of Electrical Engineers, Pacific general meeting, Multnomah Hotel, Portland, Ore., August 20-23.

Eleventh Annual Appalachian Gas Measurement Short Course, West Virginia University, Morgantown, W. Va., August 27-29.

September

American Chemical Society, 120th national Diamond Jubilee meeting, Hotel Statler, New York City, September 3-7.

Pacific Coast Gas Association, annual convention, Fairmont Hotel, San Francisco, September 4-6.

Michigan Petroleum Association, annual fall convention, Ramona Park Hotel, Harbor Springs, Mich., September 6-7.

International Union of Pure and Applied Chemistry, sixteenth conference, Hotel Statler, New York City, September 8-9.

New York Oil Heating Association, Inc., Hotel Statler, New York City, September 10.

International Congress of Pure and Applied Chemistry, twelfth conference, Hotel Statler, New York City, September 10-13.

Instrument Society of America, Coliseum, Houston, September 10-14.

American Society of Mechanical Engineers, Industrial Instrument and Regulators division, Coliseum, Houston, September 10-14.

National Petroleum Association, Hotel Traymore, Atlantic City, September 12-14.

International Union of Pure and Applied Chemistry, sixteenth conference, Hotel Statler, Washington, D. C., September 14-15.

American Institute of Chemical Engineers, national meeting, Sheraton Hotel, Rochester, N. Y., September 17-19.

Western Petroleum Refiners Association, regional meeting, Hotel Henning, Casper, Wyo., September 20-21.

American Association of Oilwell Drilling Contractors, eleventh annual meeting, Texas Hotel, Fort Worth, September 24-25.

American Society of Mechanical Engineers, sixth petroleum mechanical-engineering conference, Mayo Hotel, Tulsa, September 24-26.

American Society of Mechanical Engineers, fall meeting, Radisson Hotel, Minneapolis, September 25-28.

October

American Institute of Mining and Metallurgical Engineers, petroleum branch, fall meeting, Oklahoma City, October 3-5.

California Natural Gasoline Association, twenty-sixth annual fall meeting, Ambassador Hotel, Los Angeles, October 4-5.

Texas Mid-Continent Oil and Gas Association, annual meeting, Hotel Beaumont, Beaumont, Tex., October 8-9.

American Oil Chemists' Society, fall meeting, Edgewater Beach Hotel, Chicago, October 8-10.

National Safety Council, thirty-ninth national safety congress and exposition, Stevens Hotel, Chicago, October 8-12.

Indiana Independent Petroleum Association, fall convention, Hotel Severin, Indianapolis, October 13-14.

Oil Progress Week, October 14-20.

American Petroleum Credit Association,

special silicate of soda for preparing silicate - brine muds that prevent hydrous disintegration of bentonitic shale. Available as dry powder or concentrated liquid.

barium sulfate with a high specific gravity especially prepared for building high weight muds needed to control the high pressure gas and salt water often associated with heaving shale.

special pre-gelatinized drilling mud starch for lowering the water loss of mud which reduces the wetting of water reactive heaving shales.

powerful dispersing agent for thinning mud and improving the wall building properties of the mud.

protective colloid which stabilizes mud and improves wall building qualities.

ready-mixed oil compound for preparing oil emulsion muds. It reduces balling when drilling sticky shale.

MARKS THE SPOT

where you need these proved

MAGCOBAR PRODUCTS

HEAVING SHALE

Heaving shale is a barrier that has scared many an operator away from areas which otherwise were considered attractive prospects for exploratory drilling. Fortunately, improvements in equipment, drilling techniques, and drilling mud have reduced the hazard of drilling in these areas to a minimum. It now appears that hole trouble described as "heaving shale" is a condition of the hole rather than a particular formation. Heaving shale is still a chronic drilling problem, but the industry has know-how and specialized mud material to control it. Magcobar is glad to have played an important part in helping the industry eliminate heaving shale from the category of an "impenetrable formation." Magcobar serves the industry with the specialized mud materials for handling this problem, and their experienced field engineers will assist you in their use. When heaving shale is a probable barrier to reaching your drilling objective—call your Magcobar engineer.

Magcobar
Complete
DRILLING MUD SERVICE
DEALER

MAGNET COVE BARIUM CORPORATION
ONE OF THE DRESSER INDUSTRIES
MALVERN, ARKANSAS **HOUSTON, TEXAS**

TUBE-KOTE PREVENTS COSTLY REMOVAL OPERATIONS

PARAFFIN DEPOSITION

Successfully Prevented

By

TUBE-KOTE

Internal Coating of Tubing, Flow Lines, and Related Equipment Pays Off In Continuous Operation

IF YOU HAVEN'T USED TUBE-KOTE . . . TRY ONE WELL

See How Effectively Tube-Kote Licks Paraffin!

Paraffin removal operations can be *costly!* . . . But they can be prevented in many cases by the application of "TK-2" SPECIAL-KOTE, a thermo-setting (baked-on) plastic coating. Major oil companies have proved the economy of using Tube-Kote to solve this problem. Complete technical service reports available on request.

TUBE-KOTE

TUBE-KOTE

First Name In Corrosion Resistance

2520 HOLMES ROAD . . . P. O. BOX 8123, HOUSTON, TEXAS

WIRE, PHONE OR WRITE FOR TUBE-KOTE TECHNICAL SERVICE BULLETIN

twenty-seventh annual conference, Adolphus Hotel, Dallas, October 15-17.

American Gas Association, annual convention, Kiel Auditorium, St. Louis, October 15-17.

National Metal Congress and Exposition, American Society for Metals, American Welding Society, American Institute of Mining and Metallurgical Engineers, and Society for Non-Destructive Testing, Hotels Statler, Book-Cadillac, and Detroit-Leland, Detroit, October 15-19.

Institute of Gas Technology, annual meeting, Chicago, October 18.

National Association of Corrosion Engineers, South Central Region, annual meeting, Corpus Christi, Tex., October 18-20.

American Association of Petroleum Geologists, regional meeting, Commodore Perry Hotel, Austin, Tex., October 18-20.

Independent Petroleum Association of America, Shamrock Hotel, Houston, October 21-23.

American Institute of Electrical Engineers, fall general meeting, Hotel Cleveland, Cleveland, October 22-26.

Society of Exploration Geophysicists, eastern regional meeting, Webster Hall Hotel, Pittsburgh, October 25.

Society of Automotive Engineers, diesel-engine division, Drake Hotel, Chicago, October 29-30.

Society of Automotive Engineers, fuels and lubricants division, Drake Hotel, Chicago, October 31-November 1.

November

Louisiana-Arkansas Division, Mid-Continent Oil and Gas Association, twenty-ninth annual meeting, Roosevelt Hotel, New Orleans, November 1-2.

American Association of Petroleum Geologists, Pacific section annual fall meeting, Ambassador Hotel, Los Angeles, November 1-2.

American Petroleum Institute, thirty-first annual meeting, Stevens Hotel and Palmer House, Chicago, November 5-8.

Gulf Coast Association of Geological Societies, first annual meeting, Roosevelt Hotel, New Orleans, November 15-17.

Rocky Mountain Oil and Gas Association, annual meeting, Cosmopolitan Hotel, Denver, November 15-17.

American Society of Mechanical Engineers, annual meeting, Chalfonte-Haddon Hall, Atlantic City, November 25-30.

Society of Exploration Geophysicists, regional meeting, Baker Hotel, Dallas, November 19-20.

Twenty-third Exposition of Chemical Industries, Grand Central Palace, New York City, November 26-December 1.

December

American Institute of Chemical Engineers, annual meeting, Chalfonte-Haddon Hall, Atlantic City, December 2-5.

Chemical Specialties Manufacturers Association, thirty-eighth annual meeting, Mayflower Hotel, Washington, D. C., December 3-4.

New York Oil Heating Association, Inc., Hotel Statler, New York City, December 10.

NOMADS

Tulsa Nomads, third Friday of each month. After Five Room, Tulsa Hotel.

Dallas-Fort Worth Nomads, first Monday of each month, Greater Dallas Club.

Houston Nomads, second Monday of each month, Ye Olde College Inn, Houston.

Los Angeles Nomads, second Wednesday of each month, Jonathan Club.

New York Nomads: September 11, luncheon, Downtown Athletic Club; September 18, golf party, Knoll Golf Club, Boonton, N. J.; October 1 and October 23, regular meetings, Louis Sherry's; December 8, Christmas dinner dance, Hotel Pierre.

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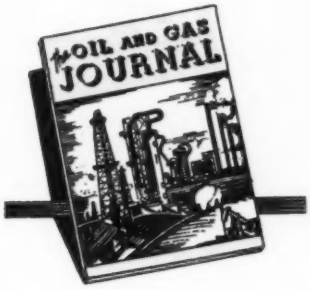

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JOURNALLY Speaking

Steel and Superlatives

THE life of a conscientious forecaster is, we would assume, full of doubts, misgivings, weasel words, and hedging phrases, a sort of on - the - one - hand - but - on - the - other - hand existence.

But when our editors put together the Midyear Review material for this issue they appear to have been freed from all the usual inhibitions and circumscriptions of the forecasting trade. They were able to climb way out on limbs with only one big "if" to crawl back on—"if there is enough steel."

You'll see what we mean when you study the reviews and forecasts in the special section which starts on page 187. Activity in just about every division of the industry is described in unmodified superlatives — "headed for new highs," "reaching for a new peak," "greatest in history." Provided, of course, the Petroleum Administration for Defense manages to allocate the operators all the steel they need to go through with their planned programs.

You see how comfortable this makes it for our boys. If their predictions turn sour by the end of 1951 they have a perfect out: "It's the Government's fault." That's an alibi that's always accepted without question. Poor old PAD gets blamed for a lot of things, but if it doesn't rustle up enough steel to let the industry do what it plans, why we're just going to put the entire blame on it if our predictions don't come true.

Incidental Intelligence

WE have almost quit talking about our Golden Anniversary issue, but we are still getting compliments from many readers, and a lot of them get quite a kick out of the old pictures which stir their memories and prompt them to send in additional information.

For instance, on page 115 was a picture of the biggest driller in Spindletop, sitting down while operating a cable-tool rig, but R. F. Williams, who loaned us the print, could supply no identification.

Now it develops that his name was Abner (Fatty) Conkle and his grandson, Harry D. Pierce, Jr., is now a unit operator for Sunray Oil Corp. at Wildhorse. The picture was taken in 1903. Conkle weighed 416 lb. and he was 72 in. around the waist. Previously he had been a driller in Pennsylvania and was born at McDonold, W. Va. Identification was supplied by Luther Williams of Sunray.

Bid & Asked

A BEMUSED colored gentleman wandered into our circulation department the other day bearing a July 13, 1950, copy of The Oil and Gas Journal and said he wanted to collect his dollar for it. Questioning brought out that a year ago a man had given it to him and told him that if he kept it a year it would be worth a dollar. To substantiate his claim he pointed to the fine print on the masthead at the bottom of the left-hand column of this page where it says "Back copies over a year old, one dollar."

As diplomatically as possible it was explained to the crestfallen individual that the dollar is the price we charge if somebody wants to buy a copy a year old, not our offer to pay for back copies. As with many other articles, there is a big difference between prices bid and asked.

If the visitor's interpretation had been correct, you subscribers would get the biggest bargain since the white men bought Manhattan Island for $24 and a case of whiskey. You would pay $3 for 52 issues, extract $1,000,000 worth of useful information, and sell them back to us for $52 a year later. It would be a neat circulation stunt, at that, only we might not stay in business very long.

Actually we sell very few old copies for $1 because our supply of extras seldom lasts a year. Like hotcakes, the Journals are in greatest demand while they're fresh (that's why we get out a fresh one every week) so our supply of extra copies is usually grabbed up in a hurry. The extra charge for old issues is because it's so much work to locate one that somebody hasn't cut up in order to file the many articles of lasting value.

—*Henry D. Ralph*

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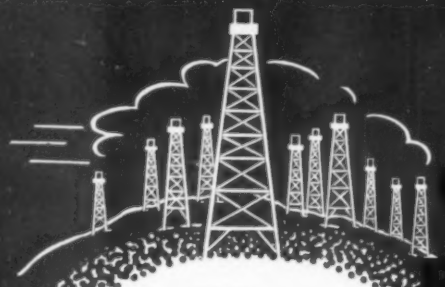

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Score at the Half

Activity in the petroleum industry has been proceeding at such a pell-mell pace that operators may well pause briefly to consider where they have gone and where they are headed. The series of Midyear Report articles in this issue of the Journal provides the bench marks for such a survey.

Every division of the industry is operating at the highest level in history and is headed for new records during the remainder of the year. This pace is spurred by a demand for petroleum products which is running about 10 per cent above 1950. If demand continues to grow at this speed for any considerable time, the industry's current operating rates and expansion plans may prove to be barely adequate.

However, the normal growth expectancy in demand is only about half the present rate, and this has given rise to some fears that the industry may be overextending itself. But these are not normal times. Demand is being stimulated by the high level of industrial activity brought about by the Government's defense program. This program is so large and so diverse that a truce in Korea should have little noticeable effect on oil requirements.

Moreover, the current nationalization difficulties in Iran are a reminder that foreign sources of oil are not always dependable. If the western world must make up the loss of oil from Iran or any other area for an extended period, the American capacity will be strained to the limit.

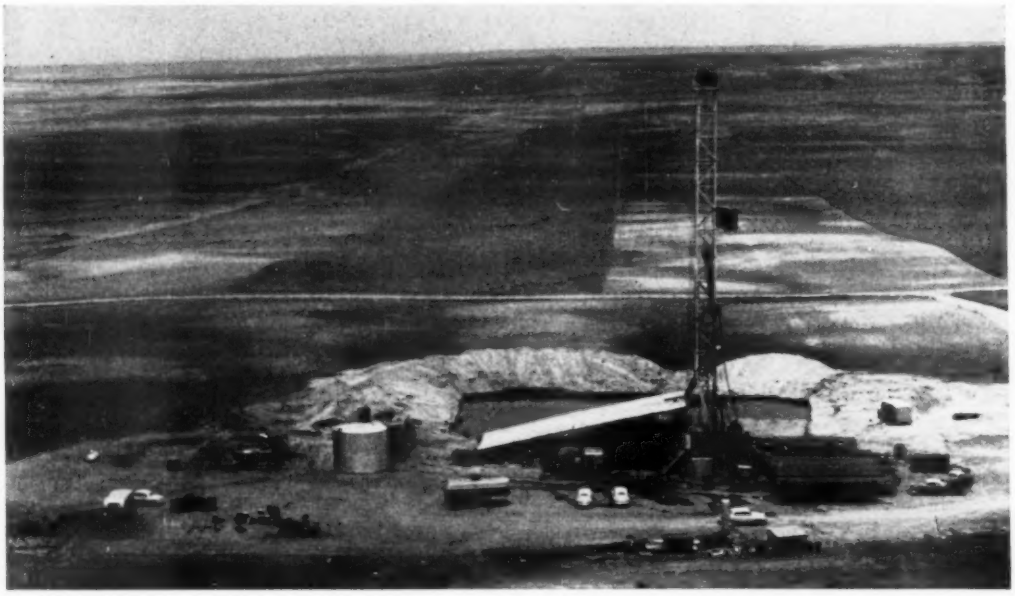
What the oil industry is doing is meeting an unprecedented demand fully and at the same time providing insurance in the form of extra capacity, insurance against a shortage growing out of an unpredictable development in the explosive international situation. The price of this insurance is a high level of stocks, a tremendous drilling and construction program, and the possibility of carrying excess capacity. The industry must pay these premiums itself, but it is cheap insurance against national disaster or the blame for a shortage from whatever cause.

Another factor in planning for the future is the availability of steel. Up to now the petroleum industry has had relatively little serious difficulty in obtaining sufficient materials. For instance, the forecast of drilling during the second half of this year is based on the amount of steel the operators believe they will obtain, not on what they would like to have if there were no restrictions on tubular goods.

In another year, as defense requirements expand, the oil industry may be less fortunate in its allocations of steel for drilling and for pipe line, refinery, and other expansion. In that case, capacity built up now will be invaluable in an emergency.

Individual operators should proceed with caution, as always, in their own expansion plans. But in view of the imponderables facing the nation it cannot be said that the petroleum industry as a whole is unwise in the scope of its planned expansion.

THIS WEEK



IMPORTANT WILDCAT.—This is Shell Oil Co.'s 1 Northern Pacific Railroad, the wildcat on the western rim of the Williston basin which is causing so much excitement in Montana. While company announcements are guardedly conservative, current reports suggest a well of major importance. The discovery adds impetus to the Williston basin activity, which already had been given a big boost by Amerada's discovery in North Dakota. For details on the new strike, see the opposite page.

INTERNATIONAL—World crude-oil production in May lacked only 16,000 bbl. of reaching 12,000,000-bbl. daily mark. . . . Gain over April was largest monthly jump in past year. . . . Canada shows big increase, along with United States. . . . Observers feel non-Communist world now producing just about at peak level. . . . ¶More conciliatory attitude apparent in Iran following talks between Averill Harriman and Iranian leaders. . . . Possibilities of reopening talks with British seen. . . . ¶Colombian Government, International Petroleum reach agreement on operation of Barrancabermeja refinery after concessions revert to government August 25. . . .

GOVERNMENT—Interior Secretary Chapman asks Louisiana to delay leasing of oil tracts in Breton Sound, South Timbalier areas. . . . Says areas claimed by Government under Supreme Court tidelands decision. . . . DPA says small third-quarter steel allocation to oil industry was no oversight. . . . Industry told materials allocation for fourth quarter may be no better. . . . Chapman, Bruce Brown fly to Mexico to look over oil situation, study needs for critical materials. . . .

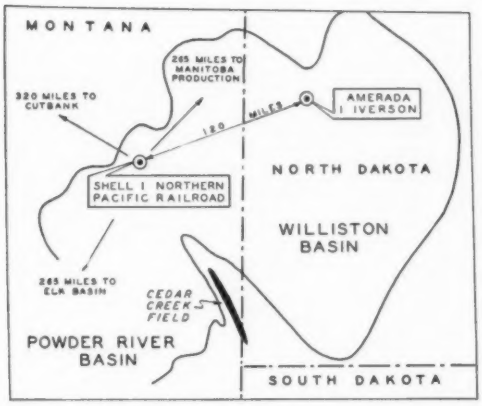
ACTIVITY—Crude production averaged 6,092,950 bbl. daily for week ended July 21, up 4,000 bbl. daily from previous week. . . . Total completions dropped 61 wells to 814. . . . Wildcat completions increased 25 wells to 216. . . . Rotary rigs operating in United States on July 16 set another record with 2,610 rigs. . . .

TRENDS—Total gasoline stocks were reduced 2,601,000 bbl. for week ended July 14. . . . Average weekly withdrawal for previous 6-week period was 677,000 bbl. . . . Stocks are 12,418,000 bbl. or 11 per cent larger than at this time last year. . . .

INDUSTRY—Survey shows octane rating of gasoline over United States dropping as result of increased demand coupled with shortage of tetraethyl lead. . . . Both regular and premium down 0.7 of a point in national average. . . . ¶Record production of sulfur seen in 1951, but shortage will continue because of high rate of exports. . . . ¶Discovery of promising new zone in Amerada's North Dakota discovery well heightens interest in area. . . .

REFINING—Sun Oil Co. announces plans for 10,000 to 15,000-bbl. refinery at Sarnia. . . . Plant will make Sarnia second largest refining center in Canada, with total crude capacity of about 106,000 bbl. per day. . . . Cities Service authorizes design and engineering of 20,000-bbl. fluid hydroforming unit at Lake Charles refinery and 10,000-bbl. unit at East Chicago. . . .

NATURAL GAS—House amends Defense Production Act to prohibit federal orders regulating gas use in states which have active regulatory agencies. . . . ¶PAD gas deputy indicates order prohibiting gas companies from adding new customers east of the Mississippi and in some areas to the west will be revamped before it is issued. . . . ¶Federal Power Commission holds it does not have authority to regulate sales of gas by Phillips Petroleum Co. . . . Ruling carries out intent of Kerr Natural Gas Act, vetoed by President Truman. . . .



DISCOVERY.—A rank wildcat which may develop into a producer of major importance is Shell's 1 Northern Pacific Railroad, location of which is shown on this map. The map shows the location of Amerada Petroleum Corp.'s North Dakota Williston Basin discovery and the relation of both wells to existing production in United States and Canada.

Shell Strike Important

New area believed opened; flow of more than 1,000 bbl. daily indicated; Amerada finds oil in new zone in 1 Iverson

BILLINGS, Mont. — Interest in the productive potentialities of the Williston basin—already at high pitch throughout the oil industry—received a tremendous shot in the arm last week with the news of a successful strike in the Shell Oil Co. 1 Northern Pacific Railroad, a rank wildcat on the western edge of the basin about 210 miles northeast of here.

All that Shell officials have said about this Richey area well, located in 19-23n-50e, Dawson County, near the western limit of the Williston structural basin in northeastern Montana, is that "a 40-minute drill-stem test was made between the depths 7,183 ft. and 7,253 ft. and the well flowed high-gravity oil at a substantial rate."

Vague as it is, this report indicates that it is probable that a highly important new oil-producing area for the newly opened Williston basin has been found.

Unofficial reports are that the drill-stem test registered an estimated 80-bbl. fillup in 35 minutes. If this fillup was not materially caused by gas, which showed at the surface in 22 minutes, influx at a rate of well over 100 bbl. per hour is indicated. The gravity of the oil is said to be 38°.

Earlier tests.—Data on four previous drill-stem tests at shallower intervals have been released.

A 1-hour test of the interval 6,870-6,934 recovered 5,520 ft. of slightly gassy salt water. A test at 6,945-98 ft., also open 1 hour, recovered 30 ft. of drilling mud. During a 61-minute test of the interval at 7,058-7,185 ft., 500 ft. of gassy, slightly oily mud was recovered. The last test prior to the one that has caused all of the excitement was at 7,060-7,186 ft. About 400 ft. of gassy, slightly oily mud was recovered.

Shut-in pressures recorded during these tests ran around 3,300 psi. after 15 minutes. On the pay-off test at 7,183-7,253 ft. flowing pressure has been unofficially reported at 3,000 psi. and shut-in pressure as 3,600 psi.

Shell has released no formation tops in this well, but most geologists familiar with the area agree that the productive interval tested is probably in Mississippian rocks. Some say upper Madison-Mission Canyon, while others believe that it could be in the overlying Charles formation. *(A brief discussion of Mississippian pools found in the southern portion of the vast sedimentary unit that takes in most of North and South Dakota, eastern Montana, and a swath across western Canada to the Arctic Circle is presented on page 371).*

Shell has run 7-in. casing to about 7,185 ft. on its apparent discovery and three 1,000-bbl. tanks are being erected on location for production tests.

As shown on the map, Shell's well is a long way from significant production. It is located about 120 miles southwest of Amerada Petroleum Corp. 1 Iverson, the first positive indication of the potentialities of the Williston basin.

New Amerada production. — Amerada's well is now testing the interval 10,490-10,530 ft., over 1,000 ft. higher than the original tested interval at 11,630-11,660 ft., which flowed over 300 bbl. of high-gravity oil daily with a gas-oil ratio of 15,000:1. Current tests after 9,000 gal. acid, with the well still cleaning, have indicated flows of over 300 bbl. of 39.4°-gravity oil daily with gas-oil ratio of less than 1,000:1.

The potentialities of Amerada's shallower, but still deep, zone are highly significant because the low gas-oil ratio will permit production that would have been unsound at the deeper zone with its high gas-oil ratio until a gas line is laid in the area.

Location of discovery.—Shell's well is 265 miles from questionably commercial production in southwestern Manitoba which is believed to be coming from Mississippian rocks near where they wedge out against the Canadian shield in the subsurface. It is also 265 miles to the big Elk Basin field, on the Wyoming-Montana line not far east of Yellowstone Park, where production is obtained from the Mississippian-Madison, the Pennsylvanian-Tensleep, and the Upper Cretaceous-Frontier.

Significant oil production to the northwest is still farther away, it being about 320 miles to the Cutbank-Kevin Sunburst area where production is obtained from the Jurassic-Ellis and Madison contact, the Madison limestone, and Cretaceous sands.

On the Cedar Creek anticline in the southeast corner of Montana, gas is produced from shallow Upper Cretaceous sands. Shell's well is located on a seismic anomaly apparently related to this long narrow structure that roughly parallels the Rocky Mountain uplift. There is also some gas production on the Bowdoin dome to the northwest near the international border.

In other words, Shell's strike is in real wildcat country. Very little is known about the variable Paleozoics and older Mesozoic rocks because deep wells are few and far apart and correlations between outcrop areas in the Black Hills of South Dakota, the Big Snowy Mountains of Central Montana, and the Big Horn Mountains of Wyoming, have not been thoroughly established. It is known that there is as much as 4,000 ft. of limestone, dolomite, sandstone and shale of Paleozoic age in this area overlain by several thousand feet of younger rocks.

Though oil and gas have been produced in Montana since 1914, nearly all of the production was from depths of less than 4,000 ft. Only in recent years have oil companies begun search for deeper and deeper horizons below old pools and into the unexplored areas where regional studies have indicated that traps suitable for the accumulation of oil and gas exist.

Leasing activity.—Leasing activity in

northeastern Montana during the past few months has been heavy and has been intensified since the word on Shell's test became public information.

The Billings land office of the federal Bureau of Land Management accepted 57 applications for leases in the first 2 hours last Monday. Over 5,000,000 acres have been leased through the northeastern portion of Montana. Counties covered in the rapid leasing compaigns were Sheridan, Daniels, Valley, Roosevelt, Richland, Dawson, McCone, and Wibaux.

Significant lease holders in the area are Carter Oil Co., The Texas Co., Texas Pacific Coal & Oil Co., Pure Oil Co., Phillips Petroleum Co., Gulf Oil Corp., Stanolind Oil & Gas Co., Sinclair Oil & Gas Co., and General Petroleum Corp.

In the current play in this area, small companies and independent wildcatters without exploration departments are making extensive use or airborne - magnetometer surveys of the Williston basin.

Interpretation of aeromagnetics is the all-important problem; however, it is much simpler than that of gravity surveys because the airborne data are not disturbed by glacial drift, with its variable thickness and density which exists as a blanket on the surface of the ground.

Interpreters of the aeromagnetic surveys are finding that, as of this date, the results are on a percentage basis, checking with seismic results. In other words, the airborne data are helping high-grade the country in that they are used to direct seismic work into likely places to find structure in the sediments overlying suspected igneous relief in the basement complex.

Geology.—Shell 1 Northern Pacific is 70 miles southeast of Glasgow and east of the east-west trending Fort Peck reservoir on the Missouri River. The area is characterized by nonglaciated plateaus, and terrace land with local badlands and isolated mountains. A few miles north of the well glaciated plateau country begins. Surface rocks are Upper Cretaceous and Eocene which dip gently south and east into the Williston basin in western North Dakota and into the Powder River basin of southeastern Montana and northeastern Wyoming.

CANADA

Sun to Build at Sarnia

New refinery will make Sarnia second largest refining center in Canada; start depends on materials availability

George Weber

PHILADELPHIA.—A long - awaited announcement that Sun Oil Co. will build a new refinery at Sarnia, Ont., was made last week by Joseph N. Pew, Jr., chairman of the board of directors. The new $10,000,000 plant, for which detailed plans have not yet been fixed, will have a capacity of from 10,000 to 15,000 bbl. per day.

It will include a combination atmospheric and vacuum crude distillation unit, a Houdriflow catalytic cracking unit of 8,000 to 10,000 bbl. capacity, plus light-ends recovery, treating, and other auxiliary facilities. The plant will probably have some catalytic reforming capacity, although no definite decision on such plans has been reached.

In view of the current tight materials situation, the date of initial construction cannot yet be set, but Sun expects to have the plant on stream by March 1953. Catalytic Construction Co. of Philadelphia has been named principal contractor.

Crude supply.—Initially at least, Sun will charge southwestern crudes to the new refinery. These crudes will be moved through the Mid-Valley Pipe Line to Lima, Ohio, the Buckeye Pipe Line to Toledo, and through Sun's new 8-in., 125-mile products line from Toledo to Sarnia. The latter line, placed in operation last December, was constructed initially to move gasoline and furnace oils from Sun's Toledo refinery to the Detroit area and to deliver light hydrocarbons, principally butylenes, to the Polymer Corp. plant at Sarnia.

On completion of the Sun refinery, the products line which is operated as part of the Susquehanna system will be converted to crude service and the Sarnia refinery will take over the supplying of light hydrocarbons to Polymer.

The new refinery will be the third of the Sun company, which operates a 140,000-bbl. per day plant at Marcus Hook, Pa., and a 65,000-bbl. per day refinery at Toledo.

It is considered quite possible that eventually, the Sarnia plant will charge Canadian crude. In 1949, a Canadian production division was organized by Sun with headquarters at Calgary, Alta. Since that time, Sun has intensified oil exploratory efforts in western Canada.

For the past several years, Sun has been considering the Canadian plant. The 120-acre site fronting on the St. Clair River was purchased from Dominion Alloy Steel Co. in 1947. Through its wholly owned subsidiary, Sun Oil Co., Ltd., the company has marketed gasoline through retail outlets in Quebec and Ontario.

New refining center.—Sun's announcement contributes to the growing importance of Sarnia as a refining and petrochemical center. By early 1953 the area will comprise three modern refineries and a major petrochemical plant operated by Polymer Corp. The largest refinery in Canada, Imperial Oil, Ltd.'s 55,500-bbl. per day plant, is currently being expanded to handle 71,000 bbl.

Canadian Oil Refineries, Ltd., now has under construction a complete new 20,000-bbl. refinery. This new plant, located at nearby Froomfield, will also incorporate a 10,000-bbl. per day fluid catalytic cracking unit and a 3,800-bbl. Platforming unit.

Including the new Sun plant, the Sarnia area will comprise three refineries totaling 106,000 bbl. per day of crude capacity plus about 72,000 bbl. per day of catalytic cracking and reforming capacity, making it Canada's second greatest refining center, after Montreal East, Quebec.

The increased refining capacity will benefit Polymer Corp., Ltd., by providing increased volumes of light hydrocarbons for conversion to synthetic Buna S, and butyl rubbers, plus rubber latices of various kinds and the new cold rubber. Also at Sarnia, Dow Chemical Co. of Canada will continue to synthesize styrene molding powders, polystyrene, and ethylene glycol, using ethylene supplied by Polymer.

Existing facilities at Sarnia represent an investment estimated at $130,000,000 to $160,000,000. Refinery and petrochemical expansion now slated for the area will add another $50,000,000 to investment in Canada's fastest-growing refining and petrochemical center.

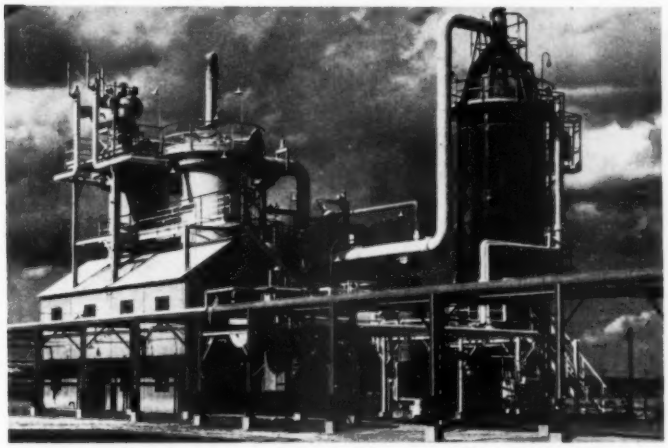
Trans Mountain Backed

TORONTO. — A half million dollars has been subscribed by four companies to conduct engineering and field surveys for Trans Mountain Oil Pipe Line Co.'s proposed 60 to 100 million dollar crude line from Alberta to Vancouver.

Socony-Vacuum Oil Co., Inc., Gulf Oil Corp., Imperial Oil Ltd., and Bechtel Corp. have agreed to contribute $125,000 (Canadian) each for the preliminary study.

Two other companies, Standard Oil Co. of California and Shell Oil Co., hold options on later participation in the project, if initial surveys indicate that the line is economically feasible.

Decision to build the line will await results of the engineering survey. Trans Mountain received its charter from the Cauadian Government early this year.



FROM SOUR GAS.—Typical plant used for recovery of elemental sulfur from hydrogen-sulfide gas is that of the Stanolind Oil & Gas Co. unit plant operator, in Elk Basin field, Wyoming, shown above. This plant can process 12,000 M.c.f. of casing-head gas each day, recovering 75 tons of sulfur as well as 56,000 gal. of liquid products.

New Record in Sulfur

But despite all-time high output, the world will have a shortage until expansion programs are finished in 1952

Joseph A. Kornfeld

DESPITE record production of crude sulfur by the United States during the first half of 1951, sulfur continues to be in short supply.

Actually, American output is more than sufficient to meet the needs of the nation's industry, but the United States is short because the sulfur industry is being called upon to ship substantial tonnages to our allies.

About 730,000 long tons were earmarked for shipment overseas in the first 9 months of the year. In addition, large amounts are being sent to Canada.

Last week the National Production Authority officially acknowledged it may have to cut the amount of sulfur allocated to industry from 100 per cent of last year's usage to a "somewhat lower, more practical figure."

Record output.—Total output of crude sulfur for the first half of 1951 slightly exceed the record level established last year. During the first half, 2,690,000 long tons were produced. Output for the full year of 1950 was 5,342,000 tons.

SULFUR PRODUCED AND SHIPPED IN THE UNITED STATES (1942-1950 INCL.)

(Source: U. S. Bureau of Mines)

Year—	Long tons shipped (apparent consumption)	Long tons produced
1942	3,128,559	3,460,686
1943	2,953,845	2,538,789
1944	3,519,083	3,218,158
1945	3,833,294	3,753,188
1946	4,128,212	3,859,642
1947	4,828,103	4,441,214
1948	4,978,912	4,869,210
1949	4,789,311	4,745,014
1950	4,780,184*	5,342,000

*Estimated.

The International Materials Conference last week announced in Washington that allocation of crude sulfur to the United States would be limited to 1,050,000 long tons during July, August and September after export of 250,000 tons for that period. Exports were slightly more than 230,000 tons originally scheduled for export in April, May, and June (actual figures are not yet available).

Total "free" world supply of sulfur is expected to be 1,415,000 long tons for the next 3 months to be allocated as follows:

	Long tons
United States	1,050,000
Great Britain	106,300
Italy	36,000
Australia	31,600
France	31,200
Remainder	159,900
Total	1,415,000

End of shortage?—From chemical circles, as reported by Chemical Week, come predictions that the end of the much-discussed world sulfur shortage may come as early as the fall of 1952.

James Boyd, director of the U. S. Bureau of Mines, estimates that the current world differential between supply and demand for the yellow chemical is as much as 1 million tons. But this deficit would be erased by the 1.2 million long tons of new capacity which will be added to the 1950 world sulfur industry's capacity of 11.7 million long tons.

Major share of additional world sulfur capacity would be in the United States, which has earmarked 640,000 long tons of additional capacity for 1951-1952.

Processwise, the additional capacity would depend heavily on the time-honored Frasch process, which would be employed in producing 530,000 long tons, all in the U. S., for 43 per cent of the total additional world capacity. Other natural sulfur would contribute 22 per cent, amounting to 262,000 long tons, all from outside the U. S.

Sour-gas sources.—Hydrocarbon gases would be the source of 202,000 long tons, or 18 per cent, of additional world sulfur expansion. These sour gases are found in such areas as the Permian Basin, the Panhandle gas field, the Smackover district of South Arkansas, the Big Horn Basin in Wyoming, and the Middle East fields.

Many refineries and chemical processes have already installed hydrogen sulfide removal equipment to "sweeten" their product. Residual gas from such equipment provides an excellent source of elemental sulfur.

Largest sulfur-recovery plant in the world is the Texas Gulf Sulphur Co. installation at Worland, Wyo. *(The Oil and Gas Journal, July 19, 1951, page 78).* It has been manufacturing successfully elemental sulfur from hydrogen sulfide for over a year.

NEW WORLD SULFUR PRODUCTION FORECAST*

(Thousands of tons of sulfur equivalent)

	For year of 1951		For year of 1952		2-year total	
Source—	U. S.	Foreign	U. S.	Foreign	U. S.	Foreign
Frasch process	80		450		530	
Other natural sulfur		262				262
Hydrocarbon gases	14	82	96	10	110	92
Pyrites				162		162
Smelter gases				45		45
Total	94	344	546	217	640	561

*Source: Chemical Week.

Octane-Rating Drop

Both premium and regular gasoline show drop of .7 of a number during second quarter; less TEL is being added

BOTH premium and regular grades of gasoline now have lower octane numbers than at the end of the first quarter.

Limitations on supplies of tetraethyl lead available for blending in civilian grades of motor fuel have resulted in a decrease of 0.7 in the average octane numbers of both premium and regular gasolines marketed in 45 cities covered in the survey of the petroleum-chemical division of E. I. du Pont de Nemours & Co., Inc.

The unweighted arithmetic average of premium gasoline octane numbers reported for the 45 cities at midyear was 89.6 compared with 90.3 at the end of the first quarter and 89.8 at the end of June 1950. Tetraethyl lead content dropped to 1.98 cc. per gallon on the latest report from an average of 2.20 cc. at the end of March and 2.32 cc. at the end of June last year.

Regular gasoline had an average octane number of 83.0, off 0.7 from the end of March and 0.5 from midyear 1950. TEL content decreased 0.34 cc. per gallon or 17.3 per cent from the same date last year. Since the percentage reductions in TEL content for both premium and regular gasolines were much larger than the increase in total gasoline demand in the second quarter over same period in 1950, a reduction in total TEL consumption is indicated.

Compared with the April report on samples taken during the last week of March and the first week of April, the July report shows only two cities with higher average octane numbers for premium and four cities with higher averages for regular. However, the 12-month decreases of only 0.2 for premium and 0.5 for regular indicate that there has been no severe loss in quality of gasoline as measured by octane ratings.

GENERAL COMPARISONS*

	July 1950	April 1951	July 1951
Premium:			
Research Oct. No.	89.8	90.3	89.6
TEL content (cc. per gallon)	2.32	2.20	1.98
Regular:			
Research Oct. No.	83.5	83.7	83.0
TEL content (cc. per gallon)	1.97	1.82	1.63

*Unweighted averages of figures for 45 cities.

COMPARISON OF MOTOR-GASOLINE SURVEYS

(Octane numbers are by research method; arithmetic averages by cities)

	Premium				Regular			
	Oct. No.			TEL content	Oct. No.			TEL content
	July 1950	April 1951	July 1951	cc./gal. July 1951	July 1950	April 1951	July 1951	cc./gal. July 1951
Aberdeen	87.6	89.7	89.1	2.55	81.3	82.2	81.7	1.67
Amarillo	86.8	87.8	88.0	1.48	80.5	80.1	80.0	1.25
Atlanta	91.6	91.7	91.2	1.84	85.0	85.4	84.5	1.77
Bakersfield	88.7	90.2	89.1	2.43	80.8	80.7	80.2	1.41
Baltimore	92.3	92.6	92.4	1.80	86.3	86.3	86.1	1.30
Boston	91.9	92.2	92.0	1.67	86.4	86.8	86.1	1.36
Calgary	84.5	84.2	84.4	2.41	78.8	80.1	78.9	1.81
Casper	88.5	89.0	88.2	1.32	81.5	81.7	81.0	1.14
Charlotte	91.1	92.4	91.8	1.77	85.2	85.4	84.9	1.67
Chicago	89.1	89.4	89.4	1.91	82.8	83.0	82.6	1.54
Cincinnati	90.9	91.5	90.9	2.46	85.3	85.9	84.6	1.50
Cleveland	90.9	91.6	90.6	1.72	86.1	86.8	85.8	1.17
Columbus	91.0	91.5	90.6	2.40	86.3	86.2	85.0	1.71
Corpus Christi	91.3	92.1	91.5	1.91	84.7	85.3	84.4	1.83
Dallas-Fort Worth	91.4	91.6	91.1	2.11	84.4	84.3	83.5	2.04
Denver	88.3	88.9	88.3	1.54	81.0	81.8	80.0	1.22
Detroit	90.4	91.1	90.8	2.04	85.8	85.9	84.7	1.32
El Paso	86.0	86.1	85.2	2.74	78.5	78.7	77.6	1.93
Great Falls	89.7	90.0	89.9	2.73	81.9	82.2	81.9	2.10
Houston	92.2	92.4	91.6	2.04	85.9	85.5	84.4	1.87
Indianapolis	89.3	89.9	89.6	2.09	83.6	84.1	82.4	2.06
Jacksonville	91.0	91.7	91.2	1.75	85.9	85.5	85.7	1.83
Kansas City	89.8	89.8	88.7	1.38	83.5	83.2	82.2	1.29
Little Rock	90.3	90.8	90.8	1.85	83.9	84.5	83.5	2.03
Los Angeles	90.8	90.2	89.7	1.91	82.9	81.7	81.1	1.44
Louisville	90.6	90.7	90.0	2.50	84.7	84.6	83.9	2.31
Memphis	90.6	90.6	90.2	2.11	84.3	84.6	83.4	1.83
Milwaukee	89.3	90.2	89.8	1.97	82.9	82.7	83.0	1.58
Minneapolis	87.8	89.7	88.8	2.13	81.9	82.9	81.7	1.74
Montreal	88.8	89.4	89.6	1.63	84.5	85.0	85.0	1.62
Nashville	90.0	90.2	89.7	1.75	84.7	85.0	83.4	1.81
New Orleans	91.4	91.8	90.2	1.84	84.6	84.7	83.4	1.38
New York (met. area)	92.4	92.1	91.8	2.11	86.2	86.5	86.2	2.01
Omaha	88.3	89.2	88.4	1.85	82.3	82.2	81.8	1.36
Philadelphia	92.3	92.3	92.0	1.68	86.9	86.8	85.8	1.53
Pittsburgh	91.2	91.9	91.5	1.92	86.6	86.3	85.7	1.93
St. Louis	89.4	89.8	88.8	1.59	82.9	83.0	81.9	1.44
Salt Lake City	87.8	88.3	87.9	1.70	79.5	79.1	79.4	.39
San Francisco	91.3	91.1	90.1	2.06	82.9	81.9	80.9	.81
Seattle	90.9	90.3	90.1	2.21	82.2	82.4	81.1	1.41
Shreveport	89.6	90.8	90.5	2.32	83.9	84.7	84.0	2.05
Spokane	90.5	90.8	89.5	1.89	82.4	82.7	82.0	1.51
Toronto	88.3	89.0	89.4	1.62	84.2	84.7	85.1	1.62
Tulsa	88.7	89.8	89.1	1.81	82.2	82.5	82.0	1.67
Vancouver		88.5	89.0	2.78		83.5	83.1	2.03
Wichita	87.1	88.2	87.8	2.34	81.2	81.3	81.1	2.08
Winnipeg		87.2	87.8	2.56		83.3	83.2	1.67

Industry Briefs

HOUSTON. — Formation of a new oil firm, Pasadena Oil Co., Inc., has been announced here by Weldon J. Hornsey, president. The first venture of the organization will be the drilling of a rank wildcat about 18 miles southwest of Houston. The test will seek pay in the Miocene at 3,000 ft.

LOS ANGELES.—Signal Oil & Gas Co. is preparing to enlarge fractionating and water-cooling facilities at its Signal Hill and Huntington Beach natural-gasoline plants. Directed toward increasing the plants' butane yield, the new facilities will cost about $500,000. Current natural-gasoline and L.P.G. capacity of the Huntington Beach plant is 130,000 gal. daily; that of the Signal Hill plant, 75,000 gal.

BATON ROUGE.—Louisiana's August allowable has been set at 640,996 bbl., virtually unchanged from July's figure of 640,669 bbl.

WASHINGTON.—Richard M. Morrison, manager of the purchasing department of The Texas Co., New York, has been appointed deputy director of the materials division of the Petroleum Administration for Defense. Interior Secretary Oscar Chapman said Morrison, who has been with Texaco 37 years, will replace Frank Watts, present director, when Watts returns to Humble Oil & Refining Co., from which he now is on leave.

Esso, Union Meeting Set

NEW YORK.—A mediation conference was scheduled this week by the New Jersey mediation board in an effort to settle a labor dispute between Esso Standard Oil Co. and two independent unions representing workers at the Bayway and Bayonne refineries.

The Bayway dispute will be handled first and the Bayonne matter will be acted upon later. Russell K. Dutcher, president of the Independent Petroleum Workers of New Jersey, which claims to represent 3,300 of Bayway's 4,400 workers, will send a delegation. The company has stated its willingness to cooperate.

The issue is not wages, but involves arbitration procedure, outside firms doing specialized work at the plants, no strike clauses, and adjustments in temporary shifts.

VISITING REFINERS.—Among refiners attending the regional W.P.R.A. meeting was this group. Left to right are: A. L. Cordell, president of Bareco Oil Co. and a W.P.R.A. director, Tulsa; R. D. McCrum, chief engineer of Cooperative Refinery Association, Kansas City; V. A. Kalichevsky, consulting chemical engineer, Magnolia Petroleum Co., Beaumont, who presented a paper on the new continuous wax-molding process; and C. P. Baker, refinery manager for Socony-Vacuum Oil Co., East St. Louis.

How to Get Steel

Refiners attending W.R.R.A. meeting given outline of procedure for obtaining materials allocated by PAD, PPA

John C. Reidel

WICHITA.—How to get steel and equipment for refineries was a topic of prime interest at the regional meeting of the Western Petroleum Refiners Association here July 20.

Herbert Hansen, an assistant director of the Petroleum Administration for Defense, explained the operations of the controlled-materials plan and applicable orders of the National Production Authority and the Defense Production Administration, particularly orders M-46, M-46B, and the forthcoming M-46C.

Steel for oil.—Hansen noted that 9 per cent of total steel allotment in the fourth quarter will go for oil and gas operations. This is for steel allocated under CMP directly for the oil and gas industry in original shapes and forms as coming from the steel mills, whether purchased directly or through a distributor. It includes line pipe, oil-country tubular goods, or steel plates and various original structural shapes.

If to this is added the steel used for fabrication by manufacturers into pumps, compressors, and other equipment, then the oil and gas industry will be using 15 per cent of total steel allotments for the fourth quarter. Fifty tons of petroleum products will be returned, it is estimated, for every ton of steel so obtained.

Materials bank account.—Operation of CMP was likened to a materials bank account. It works this way: (1) Program adjustments committee of the DPA allots a given amount of steel to PAD; (2) this is broken down into allotments according to the different divisions of the oil and gas industry; (3) each of the three materials is classified into various accounts. Steel, for example, is classified into carbon steel, alloy, and stainless, and these further divided according to principal shapes; line pipe according to size, whether larger or smaller than 16 in.; further division is made into allotments for construction and under MRO (maintenance, repair, and operating supplies).

Principal orders issued under CMP for the oil industry include M-46, which tells how priorities assistance may be obtained; Supplement 1 to M-46, explains allotment numbers; M-46B, material use order, restricts use of controlled materials obtained with or without priorities; and the M-46C order, expected to be issued in the more-or-less near future, which will be an inventory order.

Complete package.—An approved PAD-26 application, Hansen carefully emphasized, is a "complete package" in that: (1) it constitutes authorization for construction, (2) makes allotments of controlled material for a given quarter, and (3) is a preferential order for pumps, motors, and other components required to complete the project. (The manufacturer gets his allotment of materials from the NPA order CMP-4B.)

Q. & A.—Refiners' interest in the workings of CMP and how it affects their steel needs was shown in the many questions shot at Hansen at the conclusion of his talk. Some of the more significant ones follow:

How are a series of small, related orders treated? Order M-46 states that any delivery order with over $25 worth of controlled materials requires approval from PAD. Also, approval is required for any order of over $5,000 worth of noncontrolled material that is obtained without priority assistance. A series of small, interrelated projects may be treated as one large project and priorities assistance obtained accordingly. By a large construction project is meant anything requiring more than 25 tons of steel. Whether the small projects are interrelated must originally be determined by the individual.

Must approval be obtained for employment of used materials? Used or reclaimed material is exempt from PAD regulations. However, if in revamping an old pump, for example, new material or parts are required, worth more than $25, then a PAD rating must be obtained.

Should a PAD rating be obtained even if delivery order is for less than $5,000 and material is obtained without priorities assistance? The safest procedure is for each refiner to obtain a PAD rating even if he does not need one now. Plans may change later and he may need a rating. Also, the area of free steel is fast fading away.

How about revalidation of orders in the present interim period, that is, while CMP operation is still being worked out? Applicants are urged to revalidate orders as soon as possible for structural shapes not available in the third quarter, before larger new allotments begin to be made for the fourth quarter.

What of foreign imported line pipe or oil-country tubular goods? These are considered part of the over-all materials bank account and treated the same as domestic pipe. A PAD rating must be obtained, in accordance with regulations. A drastic cut in exports and imports may be expected. There is no sense in shipping it out then importing it back.

How do you draw the line between MRO and construction projects? Strictly speaking, replacement is MRO. This means replacement in the same capacity but not necessarily in kind. In other words, if a refiner has a 10,000-bbl. per day crude-distillation unit which he wishes to replace with a 15,000-bbl. per day unit, that is not MRO. However, he may replace it with another 10,000-bbl. crude unit even if the new equipment is much more modern than the old one was and incorporates many features the old one did not have.

How about priority assistance for laboratory construction? This now operates under M-46. (Originally was under NPA order M-71.)

How long does it take to process a PAD-26 application? This question was referred back to the refiners present. Consensus was that it took about 7 to 10 days.

Flood Hits Industry

Rampaging rivers in Kansas, Missouri leave heavy damage to terminals, bulk plants; companies begin clean-up job

KANSAS CITY. — Oil companies this week were cleaning up their plants and repairing damaged facilities following the disastrous Missouri-Kansas flood of the past 2 weeks.

Oil-industry damage estimates ranged up into the millions, with principal loss falling on owners of bulk plants and terminals on the rivers serving the many cities hit by the rampaging waters.

Pipe lines.—The flood halted all shipments through the Great Lakes Pipe Line Co. system, which handles products for 18 refineries and two other pipe lines. The company's big terminal in the Fairfax industrial district of Kansas City, Kans., at one time was 12 ft. under water. This week, however, Harry Moreland, president, said the system is expected to be back to 95 per cent of capacity by the end of next week.

Service Pipe Line Co. reported its communications system knocked out by the rampaging waters, but said that crude-oil movement fell only a little below normal. Four river crossings of the company were washed out near Topeka.

Lines of Skelly Oil Co., Magnolia Petroleum Co., and Cities Service Oil Co. in the Madison-Virgil area were broken, and additional river-crossing washouts occurred in other flooded areas.

Refining.—Principal refinery casualty in the flood was the Phillips Oil Co. refinery in the Fairfax district of Kansas City. The plant was inundated and shut down, but Phillips officials said the plant damage was negligible, there was no loss of products in storage, and full-scale operation was expected "in the near future."

Distribution. — Bulk plants and terminals of half a dozen or more companies were destroyed or badly damaged

Socony-Vacuum Oil Co.'s river terminal at Kansas City was put out of operation, with damage estimated by the company at $100,000, not including products. The company also reported damage to facilities in Topeka, Manhattan, Lawrence, and at other points.

Standard Oil Co. (Ind.) reported that more than 50 bulk plants in eastern Kansas and western Missouri were flooded.

Phillips Petroleum Co. lost two bulk plants plus a substantial amount of products in storage.

A Continental Oil Co. warehouse was flooded and eight storage tanks damaged.

Battenfield Oil & Grease Co. had two warehouses with 150,000 sq. ft. of storage space flooded, with heavy damage to packaged oils.

Sinclair Refining Co. reported 70 to 80 tank cars inundated, a warehouse full of packaged oils flooded, a pipe-line terminal at Coffeyville flooded, bulk plants at Topeka and Chanute destroyed, and a bulk plant at Manhattan flooded.

Companies not affected by the disaster cooperated with those unable to get supplies in order to prevent a shortage of products in the stricken area.

The 38,000-bbl. Sugar Creek refinery of Standard Oil Co. (Ind.) near Kansas City supplied nearly 2,000,000 gal. of products to companies whose only supply source had been shut down.

Company announcements indicated that immediate restoration of all damaged facilities would be undertaken and that the Government would not be asked for any assistance.

Dual Completion O.K.'d

WICHITA.—In a measure designed to conserve steel casing, the Kansas Corporation Commission last week granted operators in the McCandless field of Stafford County permission to produce from two reservoirs into the same well bore.

The commission granted the request of Atlantic Refining Co. and Cities Service Oil Co. for permission to produce from the Lansing-Kansas City lime series and Simpson dolomite formation.

T. A. Morgan, state conservation director, said that the authority was limited to the one field which exhibits no water problem at this time and which is considered ideal for testing efficiency of dual-completion methods.

TECHNOLOGY

Automatic Tester

Push-button unit simplifies Engler distillation test

WICHITA. — The push-button age has invaded the refinery testing laboratory in the form of an electronic apparatus which performs the Engler distillation test automatically. It was displayed here last week at the regional meeting of the Western Petroleum Refiners Association.

All the human attendant has to do to make the A.S.T.M. D 86-46 distillation test is to set the charged flask on the heater and insert the thermocouple, set a dial for the initial heat rate, and push a button marked "Start." The robot technician then takes over, automatically controlling the heat to the flask and recording results on a temperature-volume-time chart.

SPEEDY GADGET. — Paul Flood, engineer with Precision Scientific Co., demonstrates operation of the automatic A.S.T.M. distillation apparatus. After selecting initial heat rate, he just pushes the button. Electronics does all the rest.

It is claimed that 10 Engler distillations can be run by this machine for every one performed manually. It is designed for routine control work and as a referee instrument for checking manual distillation run by different operators.

The secret of the apparatus is electronic components housed in a pull-out panel. These include a temperature controller, three timing motors, and phototubes that catch the first drop over and follow the distillate up the receiver graduate. The instrument was initially designed by Shell Development Co., which licensed its manufacture to Precision Scientific Co.

The new automatic method eliminates errors since temperatures are recorded continuously. Essential components of the equipment are: (1) a heater designed for quick response to variable demand of heat; (2) a thermocouple with thermal characteristics similar to the A.S.T.M. mercury-in-glass thermometers; (3) provision to set initial heat so that the first drop will fall from the condenser tube within 5 to 10 minutes after heat is applied; and (4) recording drum with chart for obtaining continuous record of temperature and volume of distillate.

Other features are incorporated for recording the initial boiling point, getting the A.S.T.M. "correction temperature," detecting the end point, and air-cooling the distillate chamber to maintain the required temperature of 55° to 65° F.

Milestone in Gas

Decision in first test of FPC authority over independent producers goes to industry; Phillips sees "signal victory"

Henry D. Ralph

THE announcement that the Federal Power Commission has decided that Phillips Petroleum Co. is not subject to regulation under the Natural Gas Act is being hailed throughout the industry as a major milestone in the development of the natural-gas industry.

The Phillips case was universally recognized as the first real test of the commission's authority to regulate production and gathering of natural gas. Had Phillips been placed under regulation, the door would have been open for FPC to regulate the gas prices and activities of all oil producers selling natural gas to interstate pipe lines. *(For the background of the Phillips case, see The Oil and Gas Journal, April 20, 1950, page 133).*

Whether or not FPC has jurisdiction over independent producers and gatherers has been a matter of argument in the commission, Congress, and the courts for several years. It was the chief controversy in the Kerr bill, which President Truman vetoed because it would have required the FPC to take the stand it has now taken on its own volition. *(For veto message see The Oil and Gas Journal, April 20, 1950, page 134).*

Chairman Mon C. Wallgren announced July 18 that the commission had decided that "under the law and the facts of record" it does not have jurisdiction over Phillips as a "natural gas company."

The commission's opinion and order have not yet been issued. Wallgren said he made the advance announcement because garbled information was reaching the public. Commissioner Thomas C. Buchanan has announced he will write a dissenting opinion, which indicates that the decision was by vote of four to one.

Appeal expected.—The commission's decision undoubtedly will be appealed to the Supreme Court, Wallgren said. Presumably such an appeal will be taken by Wisconsin and Michigan intervenors who contended that federal regulation of gas-field prices is necessary to protect consumers.

The Phillips case was brought by the commission in October 1948, but hearings did not start until April 1950. The case arose because Phillips is the sole supplier of natural gas to Michigan-Wisconsin Pipe Line Co. It gathers and processes its own and others' gas produced in western Kansas, Oklahoma, and Texas, but does not engage in interstate transmission. Regulatory agencies in Wisconsin and Michigan complained that prices to consumers could not be regulated effectively unless FPC took jurisdiction over such producers and gatherers and fixed the field prices of gas.

The Natural Gas Act ostensibly exempts independent producers and gatherers from FPC jurisdiction, but interpretation of the language has been at issue for several years. The commission's decision in the Phillips case is the first clear-cut, authoritative ruling on the question. It establishes a precedent, and the facts involved are typical of those throughout the oil and gas industry.

Oil men were quick to hail the decision as opening the way for greater development and sale of natural gas. Fear of being regulated as a public utility, it was said, has deterred many oil producers from selling their gas to interstate pipe lines.

Phillips statement.—This was the theme of K. S. Adams, chairman of the Phillips company, who said: "This is a signal victory for producers. It is also a victory for the consuming public, although some of their representatives in these proceedings do not seem to realize it.

"An unregulated industry can and will develop far greater supplies of this premium fuel than could ever be expected through regulation. Greater supplies and free competition between gas producers and with other fuels will hold prices at reasonable levels."

Several other leaders in the industry made similar comments, though some warned that the decision might be reversed by the courts, Congress, or a change in the personnel of the Federal Power Commission.

Tidelands Vote Certain

WASHINGTON.—The Walter bill to return control of the tidelands to the states has been granted a rule by the House rules committee, thus assuring that the bill will come up for House action.

This represents a victory for Speaker Sam Rayburn, who has been pushing to get the measure before the House prior to Ed Gossett's resignation from Congress as Texas representative at the end of this month.

Although the bill was authored by Chairman Francis J. Walker (D., Pa.) of the House judiciary committee, which first reported it, Gossett is regarded as one of its most ardent supporters.

The Walter bill returns ownership of oil lands for 3 miles beyond low-water mark to the states. The 3-mile provision applies to all tidelands states except Texas, where a 10½-mile area is provided in the bill due to a clause dating back to the state's admission to the Union.

The bill provides that 38 per cent of revenues collected from leases in the areas in question shall go to adjacent states.

Gas-Order Change

More flexibility sought; Congress may kill plan

WASHINGTON.—The gas-limitation order probably will be rewritten before it is issued to provide a larger degree of local flexibility.

Following an all-day meeting of the Gas Industry Advisory Council July 23, C. Pratt Rather, Petroleum Administration for Defense deputy administrator for gas, said most gas-council members agreed that modification of the proposed order is necessary.

The order as originally announced prohibited gas companies from adding new customers generally in areas east of the Mississippi and in some states to the west.

Rather said many council members opposed the idea of blanketing a large area. As a result, he said, PAD may reverse its approach, start with a smaller restricted area, and extend the use-limitation order from area to area as it becomes necessary.

He said further that PAD does not want such a total freeze that appliance manufacturers and dealers will be unable to liquidate their inventories, even in the critical areas.

Upsetting amendment.—Both Rather and Interior Secretary Chapman were disturbed by an amendment to the Defense Production Act adopted unexpectedly by the House.

It would forbid any federal order restricting use of natural gas in any state where a state regulatory agency has the power to restrict the use of gas and certifies to the President it has used this authority.

Rather said the amendment would "completely take the guts out of the order." He said he wants cooperation from state commissions and suggested that perhaps they could initially make findings under the PAD order.

In suggesting that the PAD order will be rewritten, Rather declined to predict when it would be issued.

No More Steel?

DPA official says small third-quarter steel allotment for oil needs no mistake; dampens fourth-quarter hopes

DESPITE prodding from members of the Senate interior committee, the Defense Production Administration officially declined to confess error in allotting only 1,583,000 tons of steel to the oil industry for the third quarter. It also refused to make any commitment to do better for the fourth quarter.

Senator Joseph C. O'Mahoney (D., Wyo.), chairman of the committee, presided over hearings Tuesday, July 17, and Thursday, July 19. At the first of the two hearings, Interior Secretary Oscar Chapman, in his capacity as Petroleum Administrator for Defense, outlined the basic steel-supply situation of the oil industry.

It was at these hearings that Chapman predicted gasoline rationing in 8 to 10 months if the oil industry did not get the steel PAD requested.

The second round was devoted to hearing DPA's side, with Melvin L. Anshen, acting deputy administrator, on the stand. Anshen is also acting director of program requirements.

DPA rebuked. — O'Mahoney opened the proceedings by quoting at length from Charles E. Wilson, director of defense mobilization, on the point that oil production must be increased. The Senator implied that DPA's allotment to the oil industry failed to square with Wilson's declared objectives, a point the Senator made several times.

Each time this point was brought up, Anshen insisted that the third-quarter allocations were "finalized" by Wilson, which is government jargon for saying that Wilson approved the final allotments.

Anshen told the group that DPA's steel policy is actually two policies. They concern supervising allocation of steel in two forms—steel generally and steel plate.

As to steel generally, the highest policy was to avoid curtailing civilian production too fast and too drastically thereby creating widespread unemployment in particular areas before the industries of those areas got going with defense production.

The over-all problem is to balance demands, he said. On an ingot basis the demands for military and civilian steel for the third quarter amounted to 29 million tons, compared with 20.8 million tons of available steel. The requirements committee had to use its best judgment in balancing the conflicting demands, Anshen said.

Senators O'Mahoney and Anderson of New Mexico insisted the petroleum industry's demands for steel were "moderate" compared with the demands from other industries.

"That's only partly true," responded Anshen. He asserted that during 1950 the oil and gas industry were expanding at a much more rapid rate than other industries which are claimants for steel allotments. He said this was especially true of the natural-gas industry.

Steel plate needed.—Fundamentally, however, the problem of the oil industry was for steel plate, the DPA official said. The demand for plate during the third quarter was for 3 million tons and the supply was 2.2 million tons.

For the fourth quarter, the program-requirements committee already has before it demands for 3.3 million tons of plate. Anshen said that the supply of steel plate for the fourth quarter is estimated by the National Production Authority at 2,480,000 tons. This figure, he said, is predicated upon the assumption that there will be sufficient scrap to keep the mills running. There is great danger, he said, that with inventories of scrap "dangerously low" this production estimate may not be met.

Under the circumstances, said Anshen, "I cannot tell you how much oil will be cut, if any, for the fourth quarter." He refused to give any commitment, saying the decision would be made in a week or so.

Conversion to plate.—Anshen declared that DPA and NPA are urging "the most rapid conversion possible of strip mills to plate." There were limits to the speed of this conversion, however. For instance, he explained, although the word has gone out to industry that perishable foods must so far as possible be packed in glass containers, it takes time to set up a production line for glass containers. Meanwhile officials cannot let food rot.

Opinion differs.—Bruce K. Brown and Anshen had a minor clash of opinion in open committee. The deputy PAD administrator declared that DPA had been aiming at an over-all limit of 85 per cent of 1950 first quarter, and since oil operations in winter are at a low ebb, this resulted in an allocation of only 73 per cent for the oil industry.

Anshen asserted that there was no 85 per cent "rule of thumb" for defense and defense-supporting industry, but instead a "balancing up of supplies where most needed" based upon the judgment of the members of the interagency-requirements committee.

Senator O'Mahoney closed the hearings Thursday with an admonition to Anshen to appreciate that, with the loss of Iranian oil, there was a "very, very serious situation" ahead.

Defense Orders Issued

WASHINGTON.—The following orders have been issued by the National Production Authority:

Amendment to M-12, July 16: Minor technical amendments relating to production by brass wire mills, foundries, and regulating the use of copper and copper-base alloys.

Amendment to M-32, July 16: Permits, but does not require, producers of chrome yellow, chrome orange, and phenolformaldehyde to refuse DO orders taking more than a specified percentage of their production.

Direction 4 to MP Reg. 1, July 17: Authorizes metal fabricators who acquire title to foreign-produced steel before arrival in U. S. to use it to augment their authorized production schedules under CMP.

Direction 1 to M-47, July 20: Reminds consumer durable goods manufacturers they have until July 31 to file applications for the fourth quarter allotments of copper, steel, and aluminum.

Chapman Views Mexican Oil

WASHINGTON.—Interior Secretary Oscar Chapman flew to Mexico this week to discuss the world-oil situation with the Mexican president and Petroleos Mexicanos officials.

Chapman, who is also petroleum administrator for defense, was accompanied by Bruce K. Brown, deputy administrator. Both men conferred with President Truman shortly before the trip was announced.

The trip is being made, Chapman said, to look over the general oil situation in Mexico as to steel requirements, amount of production, etc.

G.A.M.A. Petitions for Pipe

WASHINGTON. — Representatives of the Gas Appliance Manufacturers Association last week demanded that the Petroleum Administration for Defense drop its proposed ban on the use of natural gas for new house-heating and industrial installations, "and concentrate on helping the gas industry to get more steel for pipe lines."

Lyle C. Harvey, chairman of the government-affairs committee of G.A.M.A., declared that more than 500,000 homes planned for construction this year were to be heated with gas.

C. Pratt Rather, deputy PAD administrator for gas, said that the industry was cutting off industrial users on a large scale and storing gas. He declared that G.A.M.A.'s assertion that 500,000 homes could be served with gas "was utterly in conflict with the facts."

SOUTHWEST

Texas Allowable Up

August production rate to be about the same as July

AUSTIN.—The rampaging Ol' Man River may yet affect Texas oil production.

This alarm was voiced at the monthly allowable hearing of the Texas Railroad Commission as members voted to raise allowables 2,623 bbl. to a total of 2,953,452 bbl. daily for August.

The change in allowables affects but two fields. Seminole pool was placed on a 22-day rate, reducing its allowable by 1,412 bbl. Restoration of Willamar pool, Willacy County, to a 24-day rate, after being on a 12-day producing schedule, raised the allowable there by 4,035 bbl. The pool had been partially shut in pending corrective measures to reduce flaring of gas.

Ralph O. Dietler, board chairman of Stanolind Oil Purchasing Co., Tulsa, was the only witness to express concern over continued high production rate. Dietler pointed out that although crude-oil stocks are not too high, the product buildup was becoming ominous, especially in view of Kansas floods. He said these floods had inundated some refineries and pipe lines and predicted gasoline stocks would probably back up in refineries, forcing some shutdowns in refinery runs.

Dietler said that such a shutdown would take a long time to correct and hoped that the commission would act promptly should emergency conditions develop.

Other witnesses at the hearing, representatives of Humble Oil & Refining Co., Magnolia Petroleum Co., and The Texas Co., expressed satisfaction of continuing the present flow rate of 24 days statewide and 19 days in East Texas.

Reserve capacity falling. — It was pointed out at the hearing that Texas oil fields now have an excess producing capacity of only 250,000 to 300,000 bbl. daily above the present allowable.

The figure compares with a reserve capacity of 550,000 bbl. daily reported last September by Commissioner William J. Murray *(The Oil and Gas Journal, September 21, 1950, page 176)*.

Chairman Olin Culberson said Texas could maintain the quarter-million barrel surplus capacity for a period of only 12 to 18 months.

The next hearing for statewide allowables was set for August 16 at Abilene.

Demand forecast. — An interesting sidelight brought out prior to the commission meeting were Bureau of Mines figures estimating market demand for Texas crude oil during August at 2,690,000 bbl. According to Chairman Olin Culberson, the commission seldom considers Bureau of Mines figures in setting allowables. He said that the bureau's estimates have practically no relation to the present storage situation.

In addition, Culberson commented, that the estimates probably do not take into consideration the Iranian situation.

80-Acre Spacing?

Magnolia pushes plan to save Spraberry-area steel

AUSTIN.—A proposal to use 80-acre well spacing in a portion of the Spraberry trend development area has been placed before the Texas Railroad Commission by Magnolia Petroleum Co. The area affected would include at least 91,400 probably productive acres in the Driver and Preston Spraberry areas of southeastern Midland and adjoining counties.

All Spraberry drilling in the area to date has been on a 40-acre basis. Allowable production, according to Magnolia's proposal, would be twice that of the wells drilled on a 40-acre basis. The area would be bounded by lines of 40-acre wells to prevent drainage to adjoining areas.

Would save steel.—The reason given for the proposal, the first of its kind before the commission, was the conservation of steel. Attorney and witnesses for Magnolia said that the 80-acre spacing would save 86,600 tons of steel by saving the drilling of 1,200 wells.

It was recommended that the proration units remain in effect only until the national emergency is over or until some specific date at least 1 year from the effective date of the order, should it be issued by the commission.

The wide-spacing proposal was hotly contested by representatives of some of the other companies interested in the area, mostly independent producers. Several major producing companies supported Magnolia's proposal.

East Texas Pressure Drops

AUSTIN.—The East Texas oil field suffered a severe pressure drop during June, according to Olin Culberson, chairman of the Texas Railroad Commission.

The average weighted bottom-hole pressure for the field decreased 6.02 psi. compared with a pressure variation which rarely exceeds 3 psi.

Observers felt that the pressure drop was a result of increased allowables of 8,596 bbl. per day over May's production. The July allowable was reduced by an identical amount, and the hope exists that the pressure drop may be partly remedied.

The billion-barrel East Texas field is believed to be the best example of conservation in the world. A salt-water injection program has been under way in the field for almost a decade, and although there have been slight fluctuations during this time, the pressure has not varied considerably from a mean of approximately 1,020 psi.

At Austin, the allowables for East Texas were unchanged for the month of August despite the pressure drop.

Pressure in the field stood at 1,018.52 psi. as of July 1, according to Culberson.

Wildcat Tests 2,341 Bbl.

MIDLAND, Tex.—Potentialities of pre-Pennsylvanian rocks toward the northern end of the deep Midland basin were further indicated last week with the completion of Pan American Production Co. 1 Breedlove for an official potential of 2,341 bbl. of 41.3°-gravity oil daily.

Located in northwestern Martin County about 30 miles north of here, Pan American's well made nearly 100 bbl. hourly through a ¾-in. choke on a 6-hour test of a Devonian section at 12,078-12,118 ft.

This discovery is the first significant production in northwestern Martin County. A little Ellenburger production has been developed about 8 miles southwest of the well, and a multiplay field is being developed near the southern line of the county about 22 miles south. The only other production in Martin County is at Mabee-Permian field.

GULF COAST

Tideland Lease Delay Asked

BATON ROUGE.—Secretary of the Interior Oscar Chapman July 23 asked the Louisiana Minerals Board to hold up leasing of oil tracts in Breton Sound and South Timbalier areas because these areas are claimed by the federal Government under the tidelands decision of the Supreme Court.

In announcing the leases the board had put operators on notice that the areas might be claimed by the Government but that it did not consider them as being offshore leases. The leases were to have been made July 26.

Chapman's letter included a report from the Solicitor General of the Department of Justice outlining the tidelands area of Louisiana claimed by the federal Government, and including the areas which the state proposed to lease. This was the first intimation state officials had that the Government had defined its claims.

New World Record

Production near 12,000,000 bbl. daily in May; further increases to offset loss of Iranian oil to be difficult

Dahl M. Duff

WORLD crude-oil production in May—the last full month before the shutdown in Iran—rose a sharp 2.4 per cent to reach a new all-time record of approximately 11,984,000 bbl. daily.

The percentage gain was the largest month-to-month increase since early summer a year ago. Part of it was attributable to the fact that Iranian production in April declined as a result of the strikes in Abadan. In May, Iran's production came back to a near record 717,100 bbl. daily.

The most spectacular increase in production from April to May was in Canada. As a result of the opening of shipping on the Great Lakes and full use of the Interprovincial line, output rose some 75 per cent from 80,800 bbl. daily in April to more than 141,000 bbl. daily in May.

Total world production, including estimates for Russia and Eastern Europe, which only 11 months ago topped 10,000,000 bbl. daily for the first time, is now close to 12,000,000 bbl. daily. The 11,984,000-bbl. daily May total represented a gain of 281,000 bbl. daily over April's average of 11,703,000 bbl. daily.

Excluding Russia and Eastern Europe—for which month-to-month production figures are not available—foreign production gained about 5 per cent to reach 4,873,000 bbl. daily. This was an increase of about 241,000 bbl. daily. The other 40,000 bbl. daily of the increase in the world total was contributed by the United States, where production climbed to 6,167,000 bbl. daily.

Maximum level reached? — Considering available oil-handling facilities as well as field potentials, it seems that crude production of the non-Communist world is now at a peak level.

Many oil men believe that only a "few extra barrels" can be squeezed out here and there. Even in the Persian Gulf, where extra field capacity is present, handling facilities such as lines and separators must be built. Venezuela is considered to be producing virtually at its maximum rate. In the United States, most of the reserve

TREND OVER THE LAST YEAR

	Western Hemisphere less U. S.	Middle East	Total foreign less Russia and E. Europe
1950—			
June	2,098.2	1,811.5	4,229.6
July	2,073.2	1,808.3	4,202.6
August	2,097.8	1,839.5	4,273.6
September	2,146.1	1,803.7	4,297.1
October	2,185.7	1,893.2	4,428.9
November	2,213.8	1,899.1	4,474.1
December	2,213.6	1,988.9	4,563.0
1951—			
January	2,210.9	1,874.2	4,450.9
February	2,220.3	1,947.4	4,536.8
March	2,254.1	1,961.1	4,581.1
April	2,261.5	2,013.4	4,632.1
May	2,312.1	2,199.8	4,872.6

WORLD CRUDE-OIL PRODUCTION
(Thousands of barrels daily)

Country—	May 1951	April 1951	May 1950
Western Hemisphere:			
Argentina	72.6	72.5	65.7
Bolivia	1.3	1.1	1.6
Brazil	2.5	2.0	0.6
Canada	141.6	80.8	62.0
Chile	1.7	1.7	1.9
Colombia	106.6	107.0	93.0
Cuba	0.4	0.2	0.3
Ecuador	7.3	7.3	7.2
Mexico	180.2	200.0	192.7
Peru	43.0	42.9	40.1
Trinidad	56.7	56.6	56.7
Venezuela	1,698.4	1,689.4	1,252.9
Total	2,312.1	2,261.5	1,774.7
Europe and Africa:			
France	5.2	5.1	1.9
French Morocco	1.3	1.3	0.8
Germany	25.7	24.9	21.5
Italy	0.1	0.1	0.2
Netherlands	14.5	14.3	14.3
Egypt	44.2	42.4	47.4
United Kingdom	0.9	0.9	1.0
Total	91.9	89.0	87.1
Middle East:			
Bahrein	30.1	29.9	29.3
Iran	717.1	565.3	670.2
Iraq	173.1	172.9	135.3
Kuwait	491.4	502.8	341.5
Qatar	48.0	47.1	24.0
Saudi Arabia	739.8	695.1	550.9
Turkey	0.3	0.3	0.3
Total	2,199.8	2,013.4	1,751.5

Country—	May 1951	April 1951	May 1950
Other Asia:			
British Borneo	100.0	100.0	82.3
Burma	2.0	2.0	1.0
China	2.2	2.2	1.5
India	5.0	5.0	5.2
Indonesia	145.0	145.0	139.0
Japan	6.8	6.8	5.4
New Guinea	4.8	4.8	4.8
Pakistan	3.0	2.4	3.8
Total	268.8	268.2	243.0
Total foreign less Russia and E. Europe	4,872.6	4,632.1	3,856.3
Estimated Russia and Eastern Europe:			
Austria	37.0	37.0	25.0
Romania	85.0	85.0	80.0
Russia	800.0	800.0	730.0
Other E. Europe	22.1	22.1	22.5
Total	944.1	944.1	857.5
Total foreign	5,816.7	5,576.2	4,713.8
United States	6,167.0	6,126.7	5,143.3
World total	11,983.7	11,702.9	9,857.1

Figures are from reliable reports in the industry or official government sources. Data for Russia and Eastern Europe are based on competent estimates; no authentic information is available on month-to-month production in these areas. Completely current reports also are lacking for certain countries of Southeast Asia. Data for earlier months have been revised where necessary.

producing capacity is located in West Texas where tank cars would have to be used for any large increase in shipments.

Stocks, not only in the United States but also abroad as far as is known, are at high levels. Some of the stock buildup outside the United States apparently has been due to the early indications of an indefinite stoppage in shipments out of Iran.

Canada.—Canadian production began to move up rapidly late in April as the commencement of shipping made possible greater deliveries by the Interprovincial line. During the week ended May 7, production in Alberta was 112,751 bbl. daily. It rose to 152,414 bbl. daily the week ended May 14, and to 152,895 bbl. daily the week ended May 21. In the week ended May 28, output was brought back to 142,536 bbl. daily in order to keep within allowable.

Venezuela.—The increase in Venezuelan production in May was a relatively small 9,000 bbl. daily. Of the country's output, 1,196,895 bbl. daily came from Western Venezuela, and 501,464 bbl. daily from Eastern Venezuela.

Very little spare producing capacity is available in Venezuela but drilling is picking up and there are still indications the government may grant new concessions before long.

Venezuelan production by weeks during May was: w .x ended May 7, 1,688,000 bbl. daily; May 14, 1,693,200 bbl. daily; May 21, 1,707,000 bbl. daily, and May 28, 1,708,000 bbl. daily. Of the production during the week ended May 28, net production plus purchased royalty by Creole was 752,129 bbl. daily or 44 per cent of the total; Shell, 593,347 bbl. daily, 34.7 per cent of the total; Mene Grande, 131,648 bbl. daily, or 7.7 per cent of the total; and International, 65,824 bbl. daily, or 3.9 per cent of the total.

VENEZUELAN PRODUCTION DURING MAY BY MAJOR FIELDS (5,000 BBL. DAILY OR MORE)
(Figures in thousands of barrels daily)

Eastern Venezuela:	
Quiriquire	78.641
Temblador	8,370
Oficina	58,475
Jusepin	16,985
Mulata	15,901
San Joaquin	7,215
Leona	6,622
Pernales	12,045
Santa Ana	5,798
Tucupita	9,751
Nipa	40,331
Mercedes	23,717
Ruiz	10,053
Dacion	10,832
Santa Barbara	17,511
Guario	5,363
Guico	11,838
Guara	58,615
Chimiri	57,716
Soto	9,310
Western Venezuela:	
Cabimas	83,046
Lagunillas	420,328
Tia Juana	188,786
La Paz	160,718
Sibucara	9,015
Bachaquero	162,783
Mene Grande	47,255
El Cubo	13,610
Mara	82,770
Boscan	16,031

Other Latin America. — Preliminary reports showed production in Mexico dropped back to 180,000 bbl. daily during May. It was reported unofficially that Pemex had cut back output from Poza Rica field on engineering advice.

Bolivia's small production rose slightly to about 1,300 bbl. daily in May. Three new wells were brought in, and although this level of production was reported to be sufficient to meet 85 per cent of Bolivia's gasoline needs, officials continued efforts to obtain participation of private United States capital in exploration and development.

Colombia's production in May was 106,600 bbl. daily, little changed from the previous month. This level apparently represents about the maximum under the additional pipe-line capacity provided a year ago. Production by concessions in Colombia during May was: De Mares, 38,022 bbl. daily; Barco, 27,742 bbl. daily; Yondo, 35,981 bbl. daily; Cantagallo, 1,305 bbl. daily; Dificil, 2,031 bbl. daily; and Velasquez, 1,565 bbl. daily.

Germany. — Western Germany's domestic output showed another slight gain to nearly 26,000 bbl. daily in May. The total in metric tons was 112,470. By area, production was Emsland, 49,356 tons; Hanover, 52,187 tons; Schleswig - Holstein - Hamburg, 10,392 tons; and Baden, 535 tons.

Middle East.—Outside of Canada, the changes of greatest interest in crude production in May occurred in the Middle East. For the entire area, the May production of nearly 2,200,000 bbl. daily represented an increase of about 186,000 bbl. daily, or 9.3 per cent, over the April total of 2,013,400 bbl. daily. Canada and the countries of the Persian Gulf thus provided all the net increase in foreign production during the month.

The production of Anglo - Iranian Oil Co., Ltd., in Iran recovered completely from the low level of 565,000 bbl. daily to which it dropped in April as a result of the strikes which partially closed the Abadan refinery. The May daily average of 717,100 bbl. daily was the greatest since the record of nearly 727,000 bbl. daily last December.

Production in Saudi Arabia gained another 44,700 bbl. daily to reach a new record of 739,800 bbl. daily in May. Kuwait production in May dropped back slightly from the 502,800 bbl. daily in April to 491,400 bbl. daily in May. Iraq production, limited to capacity of present pipe lines from Kirkuk field, was little changed at 173,100 bbl. daily. This will go up considerably in the near future when the Basrah area is opened to production, and next year, the new 30-32-in. to the Eastern Mediterranean is due to go into operation.

Available information indicates current production in Austria is approximately 37,000 bbl. daily and possibly even greater. The increase over earlier estimates is due to development of Matzen field in the Vienna basin by the Soviet Mineral Oil Administration. Of the total, 22,000 bbl. daily or more is credited to Matzen.

In Southeast Asia, reports now are that the production of about 100,000 bbl. daily reached earlier this year in British Borneo is being maintained. Indonesia's current production is estimated at 145,000 bbl. daily with most of the increase in the last 6 months coming from development work in Indonesian Borneo. Japan's production has shown another slight rise in recent months and is now reported to be nearly 7,000 bbl. daily.

MIDDLE EAST

Harriman Optimistic

American mission to Iran reports some progress made; however, oil men here look for further deterioration

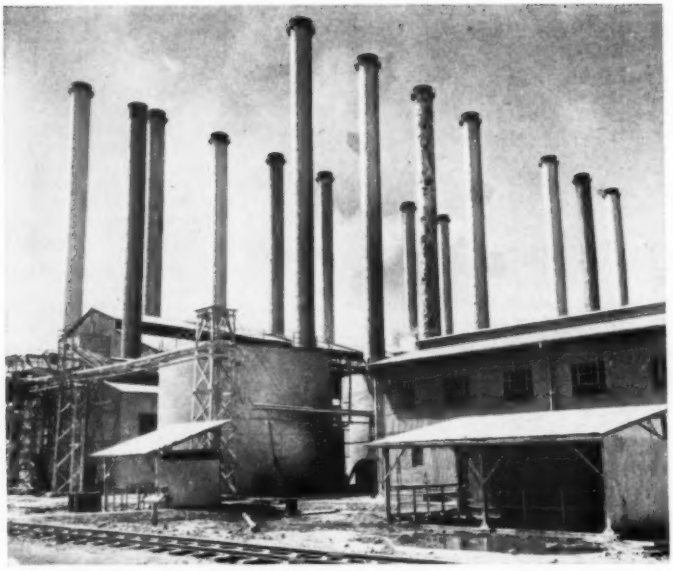
THE Harriman mission to Teheran appears to be swinging the Iranian Government around to a more conciliatory attitude, but whether it will be able to work out a formula acceptable to the British is in question.

Harriman, President Truman's personal representative, held lengthy meetings with the Iranian Government's oil-nationalization board over the week-end. All that was revealed after these sessions was that "some progress" had been made.

Harriman's difficult task is to bring the Iranians and British together on some basis for joint participation in the Iranian oil operation. Harriman was reported optimistic.

Iranian authorities have told Harriman they are ready to reopen talks with the British but have reiterated they will not yield in their determination to adhere strictly to terms of the nationalization law.

In the absence of some assurance from the Iranians that they will not insist on the same conditions that broke up the negotiations last month, further conferences with British representatives are considered to be useless. In last month's talks, the Iranians



SMOKELESS STACKS.—Production at Anglo-Iranian Oil Co.'s huge Abadan refinery has dropped to almost nothing—and these stacks show it. Some portions of the sprawling refinery are completely shut down, and others are operating on a limited basis. No products have been moved out of Iran since June 22.

demanded 75 per cent of the company's net receipts as a condition for continuing the meetings.

Pessimism prevails.—Pessimism was still the dominant note among informed oil men in New York. Many believe the situation in Iran will "get worse before it gets better." One official expressed the belief Iran will "sink all the way down before it comes up," while another said the Iranian statements about willingness to reopen negotiations were only a face-saving offer for Harriman.

In Teheran, Harriman had several meetings with Premier Mossadegh, the leader of the nationalization drive, members of parliament, the shah, and others. He was assisted by Walter J. Levy, New York economic consultant, who met with Kazem Hassibi, member of the government's oil-nationalization board and one of the most outspoken proponents of the move to take over the British properties.

After one of his talks with Levy, Hassibi said Levy kept dwelling on the difficulties which Iran would encounter in course it is following. "We replied we were well aware of these difficulties," Hassibi said. "It goes without saying that a great undertaking must entail difficulties, and the recovery of our inalienable rights is a great undertaking. We have a law to guide up, and we will be faithful to that law. . . ."

Iran steadfast. — Hassibi's statement along with other reports coming out of Teheran showed that the position of the Iranians is apparently unchanged as a result of the Harriman discussions. After President Truman's envoy met with the nationalization board, Hassibi said Iran was prepared to sit down again and talk with the British but that "we are not prepared to back down on the principle of nationalization."

The British have conceded the principle of nationalization but insist that the future of the properties be settled by negotiation, not expropriation. B. R. Jackson, deputy chairman of Anglo-Iranian Oil Co., Ltd., in the unsuccessful negotiations in June proposed that the Iranian national oil company grant the use of the oil properties to a new company to be established by Anglo-Iranian which would include Persian directors.

Harriman threatened.—Harriman, whose purpose in going to Iran was to attempt to create an atmosphere favorable to settlement, carried out his mission in Teheran under constant threats of violence. A number of persons were killed in riots stirred up on his arrival. This was followed by dismissal of the city's police perfect and a roundup of Communists who participated in the disturbances.

Teheran police said an attempt to assassinate Harriman was likely. Special precautions were taken for his protection. His temporary home was under heavy guard, and he was accompanied on his trips in the city by three or more jeeps loaded with police.

There seemed little doubt that, in the emotional state ruling in the Iranian capital, the stand of the government against any compromise on the oil issue had the support of much of the public.

American opinion shifts. — In some American oil circles, there seems to have been a shift of opinion recently in regard to the ability of the Iranians to operate the vast British-built industry. Drawing in such European countries as Germany and Italy for technicians, Iran, it is felt, could operate the properties at a reduced level indefinitely. At least they could get the oil to dockside.

Nobody yet has come up with the answer as to how the Iranians will provide the approximate 250 tankers needed to move the production. One source said it must be remembered there is a great difference between taking over and running properties and going out and exploring for oil with all the risks and discouragements that are involved.

Iranian officials persist in the belief that in the final analysis they will be bailed out of their oil-nationalization difficulties by the United States. Despite all the preparations being made for long-term replacement of Iran's production and statements of government officials in this country, Iranians still feel that the United States will come to their rescue to keep the country in the non-Russian orbit and to prevent the loss of its oil to the western world.

Little interest here.—As has been predicted from the outset, the only groups to indicate any interest in taking oil from the nationalized Iranian company have been organizations not connected with any of the larger companies that supply practically all the world's markets. It has been reported the International Cooperative Petroleum Association is interested, but Howard A. Cowden, executive secretary, denied any offer had been made.

Iranian officials in Teheran said they had had an offer from Columbus Export Co., a New York City firm, but this and all other possible purchasers in the United States predicated any offer on State Department approval.

Earlier, there were indications the Italian state oil company might buy from the Iranians. It has been felt all along that some of the countries of southeastern Asia might take products from Iran as an expression of sympathy—provided of course tankers could be found.

Abadan runs slump.—The Abadan refinery is continuing to operate at greatly reduced throughput, last reported to be well below 100,000 bbl. daily. Nearly half of the company's personnel have been evacuated, and the remainder are staying on largely in a caretaker status.

The Iran Government has placed more advertisements in publications

in this country and abroad offering oil at prevailing prices but specifying that the purchasers must supply their own ships. The government group earlier had advertised to notify Anglo-Iranian's former oil takers that they must contact the government company for their requirements. None of them responded.

The Iranian Government's hostility toward company officials abated somewhat when it dropped plans to cancel the residence visa of Norman R. Seddon, Anglo-Iranian's chief Teheran representative. The government ordered two Anglo-Iranian staff members to Teheran, but later indicated it would allow them to leave the country without reporting to the capital.

British officials at Abadan are fearful that violence may break out in that area. Last week, British sources said a member of the company's British staff was beaten at Haft Kel field and that they had been advised it might not be safe to send investigators.

LATIN AMERICA

Colombian Accord

I.P.C., government agree on operation of refinery

FINAL agreement between International Petroleum Co., Ltd., and the Colombian Government oil company on operation of the Barrancabermeja refinery after August 25 has been confirmed by the company in an announcement from its Toronto headquarters.

The refinery is a part of the De Mares concession which on the August date will revert to complete government ownership in accordance with the original terms of the 30-year oil concession.

The announcement said International and its wholly owned subsidiary, International Petroleum (Colombia), Ltd., will occupy, use, and operate the refinery with complete autonomy. As compensation, International Colombia will pay a fixed annual amount plus fees which will vary with the barrels charged in the plant.

On Colombia's side, the agreement was with the Colombian National Petroleum Co., Empresa Colombiana de Petroleos, which was organized by the government to handle the properties.

New facilities. — International said Empresa has undertaken to construct as soon as possible facilities to process 35,000 bbl. of crude oil daily, including pipe still, visbreaker, fluid catalytic cracking unit, light-ends recovery unit, aviation-alkylation unit, and other additions and improvements.

It is estimated the new facilities will cost about $20,000,000. International has agreed to lend the government organization $10,000,000 toward the project, to be repaid over a period of 10 years.

10-year pact. — The refinery agreement runs for 10 years from the date on which the Empresa delivers to the company the entire new plant. There are provisions for termination by either party approximately 7 years from August 25, 1951.

International Colombia has undertaken to purchase crude from Empresa, and, under Colombian price-control regulations, will sell the refined products required for consumption in Colombia at prices equal to the average of the United States gulf. Products, including reduced crude, not sold in Colombia, may be exported.

International Colombia also has agreed to provide Empresa with technical assistance in the producing phase of the De Mares operation. The International announcement said such assistance will be provided at cost for a period of from 3 to 5 years as Empresa may elect.

Terms differ.—Terms of the agreement as summarized in the International announcement were considerably different from those outlined some time ago in the tentative memorandum of agreement. Originally a profit-sharing formula for the refinery was provided, and a percentage of production payment for technical production assistance.

De Mares is the largest oil property in Colombia, and production from the present 25,000-bbl. daily Barrancabermeja refinery meets a major part of the country's international requirements. Another International subsidiary, Tropical Oil Co., is the only important marketer of petroleum products in Colombia.

CIMA Starts New Test

Commencement of an exploratory well on the Tecominoacan structure about 55 miles east of Rabon Grande on the Tehuantepec Isthmus area of Mexico has been announced by Ralph K. Davies, president of American Independent Oil Co.

Seismic survey work at Tecominoacan has indicated a promising structure of large areal extent, Davies said.

Locations for the test is in heavy jungle. Tropical storms and thick underbrush pose severe transportation and operating problems in the area.

Drilling operations will be carried on by Mexican American Independent Co. (CIMA), an associated organization. CIMA recently reported an important oil discovery at Rabon Grande. *(The Oil and Gas Journal, July 12, page 71).*

EUROPE

Condor Line Pipe on Hand

All of the pipe for the crude-oil line of Condor L'Industrie Petrolifera e Chimica has been received. Construction is expected to start in October for the company's Genoa-Rho, Italy, 90-mile, 12-in. line, which will be served by one pump station. Completion is scheduled for the fall of 1952. W. G. Heltzel is consultant for the project.

The early work on the line will be carried on by hand methods on the seacoast and along the route through Bochetta Pass at an elevation of 2,500 ft. in the Apennine Mountains. Difficulties are presented not only by mountainous terrain but also by numerous rice fields.

In the open country beyond the mountains it is expected that modern construction machinery will be used. Contracting of the project has not yet been decided.

The line will be operated at 1,200 psi. for throughput of 25,000 to 30,000 bbl. per day to supply the Condor refinery now under construction.

The Condor and the Sarpon projects represent the first important crude-oil pipe lines in Italy.

The Sarpon line is now being built by Caltex interests from the port of Savona on the coast of the Ligerian Sea to San Martino de Trecate, east of Turin, Italy. This line consisting of 90 to 100 miles of 8-in. will supply the refinery now being built by Sarpon.

FAR EAST

Holdings in China Seized

The Chinese Communists last week announced the seizure of all property in Red China of Standard Vacuum Oil Co., Caltex, Ltd., and Chinese American Oil Co.

Although the Reds ordered the seizure of all American property in China last December 29, the oil companies apparently had not been physically taken over until July 18. However, they had been under strict Red control since the December date.

A Peiping broadcast said the seizure was announced at a meeting of oil-firm managers in Shanghai and that all oil stocks were purchased by the government on a compulsory basis.

The broadcast said Chinese workers had pledged themselves to "increase production" in order to buy more planes for the Chinese armed forces.

This posed somewhat of a mystery to observers since China is not an oil-producing country. The only oil stocks which American companies could have had on hand would be imports, and this country's present embargo on shipments to Red China makes it unlikely they could have been large.

PERSONALS

Busy Executive

S. F. Bowlby began long Shell career in 1926

UP in Shell Oil Co.'s Los Angeles office you will hear that S. F. Bowlby can make a quick and lasting decision. In fact, back in 1926 he got his start in the oil business that way, and that faculty has led him to his present position of regional vice president in charge of exploration and production for the West Coast and Rocky Mountains divisions.

Bowlby was graduated from the Wisconsin Institute of Technology in 1926 in mining engineering and had only remote thoughts of the oil industry as a career. After a summer with Roxana Petroleum Corp., now a part of Shell, working as a roustabout in the Texas Panhandle during the Borger boom, Bowlby attended and received a degree in petroleum engineering from the University of Oklahoma.

After leaving the university, Bowlby rejoined Shell in the Texas Panhandle as a roustabout. Subsequently he became a tool dresser, then joined Shell's engineering staff.

Bowlby's initial engineering assignment was at Marshall, Okla. He was given the task of determining why Shell's newly drilled deep-rotary holes, like others of the day, were not straight. While on the job he conducted some of the early investigations on rotary mud and techniques for measuring the inclination of drilling wells.

Following various engineering assignments, and a return to operations on a 12-hour tour basis during the depression, Bowlby resumed his engineering career in 1933. A special assignment took him to Europe in 1935. On returning to the United States, he became chief exploitation engineer in Houston, and then division manager for Shell in southern Louisiana.

Bowlby's first California assignment, in 1940, was in the Los Angeles office as chief exploitation engineer. Subsequently he became division manager in the Los Angeles basin and San Joaquin divisions. He was appointed vice president in charge of exploration and production for Shell's western operations in 1946 at the age of 41.

Although a 1949 promotion made him the busiest man in the Los Angeles office as regional vice president in charge of exploration and production for the West Coast and Rocky Mountains, Bowlby's after-work hours are full.

He is a member of the Pasadena Investors and Thrift Association, and in Los Angeles, a director of the Welfare Federation of Los Angeles Area, member of the California Club, the Petroleum Club, and a past president of the Petroleum Production Pioneers. He is a director of the R. M. Pyles Boys' and Girls' Camp which helps underprivileged boys enjoy a summer vacation in the Sierras.

Don C. Wise has been appointed chief engineer of New York State Natural Gas Corp.'s Oakford station, now under construction at Delmont, Pa. The station is expected to cost $7,500,000 and is a part of the $40,000,000 Oakford storage-pool project being jointly developed by New York State Natural and Texas Eastern Transmission Corp.

E. A. Milz, assistant reservoir engineer for Shell Oil Co. at Oklahoma City, has been transferred to Wichita Falls, Tex., as reservoir engineer.

David P. Johnson, district geologist at Abilene, Tex., has been transferred to Corpus Christi in charge of exploration for that district.

H. P. Reardon, assistant division petroleum engineer for Gulf Oil Corp., has been named to the newly created position of reserves coordinator in the Fort Worth production division. **A. L. Holland, Jr.,** was promoted from group petroleum engineer to succeed Reardon as assistant division petroleum engineer. **O. K. Gilbreth, Jr.,** formerly special petroleum engineer, was promoted to group petroleum engineer, with **L. E. Holden, Jr.,** named special petroleum engineer.

Robert V. Sellers, with the crude-oil supply and transportation department of Cities Service Oil Co. at Bartlesville, Okla., has been named assistant to the director, production division, of the Petroleum Administration for Defense at Washington.

R. F. MARSCHNER

R. F. Marschner, section leader on the research staff of Standard Oil Co. (Ind.), has been promoted to senior research associate at the firm's Whiting, Ind., research laboratory. He joined Standard's research staff in 1934 and has been a section leader since 1946. He is the new chairman of the American Chemical Society's Chicago section. **B. L. Evering** has been promoted to research associate. He joined Standard in 1934 and has been a group leader since 1943. **A. P. Lien** was promoted to section leader. He joined the firm in 1941 and has been a group leader since 1946. **D. R. Carmody** and **C. E. Johnson** were promoted to group leaders.

Charles C. Green, who has been division geologist for Texas Gulf Producing Co. since the concern started operations in the Permian basin in 1945, has resigned to become a consulting geologist in Midland, Tex. He will also be associated with Cactus Drilling Co. as soon as an office is established by the firm in Midland. He joined Shell Oil Co. in 1937 after graduating from Oklahoma University, leaving after 9 years to join Texas Gulf in 1945.

Reavis P. Lowman, geologist with Superior Oil Co. for the past 3 years, has resigned to become a consultant and independent operator.

W. H. Roe, formerly petroleum engineer with Superior Oil Co., has joined Stanford Oil Co. at Evansville, Ind., in charge of production.

Roderick J. Forsyth, independent petroleum geologist, has moved offices from Mount Vernon to Evansville, Ind.

Clifford Keller, assistant superintendent of oil production for Solar Oil Corp., has been transferred from Geneseo, Kans., to Wichita.

Harry H. Emmerich, formerly geologist for Magnolia Petroleum Corp., at Dallas, is now a consulting geologist with the firm of Tomlinson, Kathol & Emmerich at Wichita.

PERSONALS

G. C. McLAREN

George C. McLaren, general superintendent of the southern district natural-gasoline department of Standard Oil Co. of California, has been elected president of the California Natural Gasoline Association, succeeding **R. S. Tulin,** of Shell Oil Co., outgoing president. **Warren H. Kraft,** director of Honolulu Oil Corp., has been elected vice president of the organization. **E. R. Millett, Jr.,** was reappointed as secretary-treasurer. The following were appointed to serve on the executive committee: **F. E. Bradley,** Chanslor-Canfield Midway Oil Co.; **C. L. Case,** Continental Oil Co.; **R. C. Enderly,** Wilmington Gasoline Co.; **Fred Hartley,** Union Oil Co. of California; **Ray Hull,** California Research Corp.; **C. L. Hutchings,** Tide Water Associated Oil Co.; **E. W. Walker,** Western Gulf Oil Co.; **P. E. Foote,** Petrolane, Ltd.; **M. L. Fort,** Pacific Lighting Gas Supply Co.; **Grove Lawrence,** Southern California Gas Co.; and **Winton J. Heinz,** Ingersoll-Rand Co.

R. A. Keppel, of Esso Standard Oil Co.'s operations-analysis department at the Everett, Mass., refinery, has been granted a leave of obsence by the firm to take an assignment as assistant to the director of the foreign refining section of the Petroleum Administration for Defense.

J. F. Lyons, formerly process superintendent at the Everett, Mass., refinery of Esso Standard Oil Co., has been promoted to the newly created position of assistant general superintendent. He is succeeded by **W. D. Sumner,** who moves up from assistant process superintendent. Newly promoted to the latter post is **R. R. Keppler,** who was technical assistant to the manager and the general superintendent.

C. R. Bickel, southern division production manager for Shell Oil Co. at Odessa, Tex., has been named manager of the northern production division at Hobbs, N. M. **E. L. Kimrey,** division production manager at Hobbs, has been transferred to Odessa. Other changes in the firm include: **M. J. Edwardson,** junior exploration engineer at Houston, transferred to Hobbs as division exploration engineer; **L. Fischer,** special-problems geophysicist on the Midland, Tex., review staff of Shell, named division geophysicist in the Midland office; **N. W. Harrison,** exploitation engineer, transferred from McCamey, Tex., to Odessa; **R. M. Hippard,** exploitation engineer at Midland, named division reservoir engineer at Odessa, for the southern division of Shell's Midland area; **K. D. Huckabee,** formerly seismograph operator, transferred to the Midland area exploration review staff; **G. O. Hult,** production department gas-design engineer, transferred from Houston to Midland; **W. G. Inabnet,** named district production superintendent at Wasson, Tex.; **C. B. Nance, Jr.,** named seismic party chief of Shell's party 131; **D. D. Ozman,** subsurface geologist, transferred from Midland to Tulsa; and **W. P. Scaife,** seismologist party chief, transferred to the exploration review staff at Midland.

Don McCarty, gang pusher for Ohio Oil Co. at Henderson, Tex., has been promoted to foreman.

Oliver Leroy Sanders, junior engineer for Sun Oil Co. at Austin, has been transferred to Beaumont, Tex.

Louis H. Dixon, senior geologist for Tropical Oil Co., has been transferred from Brazil to Bogota, Colombia.

Frank Ficklin, engineer for Sunray Oil Corp., has moved from Midland to Odessa, Tex.

L. H. Byrd, assistant district superintendent of the East Texas division for Humble Oil & Refining Co., has been transferred to the California district, Gulf Coast division, as assistant superintendent. Other changes in the firm include: **J. T. Knauth,** assistant district superintendent, transferred from the Friendswood, Tex., district, to the Lovell, Tex., district; **H. V. Wait,** district petroleum engineer, transferred from the Galveston Bay, Texas, district, to the Louisiana division office at New Orleans as supervising petroleum engineer; **William F. Shelton,** petroleum engineer in the Grand Isle district in Louisiana, transferred to the economics and statistics division at Houston as senior petroleum engineer; **Jack M. Shepherd,** supervising petroleum engineer, has been named assistant district superintendent of the London district, East Texas division.

Carl T. Kallina has been appointed chief of the gas-certificates division of the Federal Power Commission, succeeding **Loring E. Heckman** who resigned recently to enter private industry. Prior to joining FPC in 1941, Kallina was a gas engineer with subsidiary companies of Washington Gas Light Co. he served as head of the engineering-analysis section of the gas-certificates division before he was named acting chief of the division upon Heckman's resignation.

Bird G. Swan, chief geophysicist for Continental Oil Co. at Ponca City, Okla., has been promoted to assistant manager of the company's geophysical section. He joined the firm as a member of a geophysical crew in 1932, following graduation from the University of Oklahoma. He became control geophysicist in 1937 and was named geophysical superintendent in 1948.

John R. Ellis, geologist for Carter Oil Co. at Casper, Wyo., has resigned and joined **Page T. Jenkins** and **Hiram D. Hand,** consulting geologists, at Casper.

E. G. Ishmael, formerly with Seaboard Oil Co. in the Rocky Mountains, has joined Skelly Oil Co. as geologist in the Casper, Wyo., division.

Joseph Drumheller, with Inland Empire Refinery at Spokane, Wash., has been named as special consultant on fuels to **Oscar L. Chapman,** petroleum administrator for defense.

E. M. Egan has been named assistant to **Sam Caldwell,** executive vice president of the Mid-Continent Oil and Gas Association. Egan succeeds **William M. Redditt, Jr.,** who resigned to become president of George Oil Corp.

Ed Harrison, geologist and geophysicist for The California Co. at Williamsport, Pa., has joined Sunray Oil Corp. in Shreveport, La., as geologist.

Richard Edmund, 1951 graduate of Iowa University, has joined Stanolind Oil & Gas Co. at Shreveport, La., as geologist.

Vernon Blain, superintendent of production for John Drilling Co., has been transferred from Hobbs, N. M., to Odessa, Tex.

Gus Kaufman has been named assistant manager of the technical and research division of The Texas Co., headed by **Dr. Wayne E. Kuhn.** A lubrication specialist, Kaufman spent 10 years in charge of grease research at the firm's Beacon laboratories prior to becoming staff technologist and assistant to the manager of the technical and research division, which position he has held until his recent promotion.

M. S. Metz, exploration manager at Shell Oil Co.'s Calgary, Canada, office, has been transferred to the Midland, Tex., area as exploration manager, replacing **H. M. Fritts.** Fritts has been transferred to New York to become a member of the staff of the vice president in charge of exploration and production. Metz joined Shell as

PERSONALS

a junior geologist in the Texas Gulf area in 1937. He was sent to Calgary as area geologist in April 1949, and became exploration manager in June of the same year. Fritts has been exploration manager since June 1949. He joined Shell in 1926 as an instrument man in the exploration department. Early in 1949 he became exploration manager in Calgary, where he remained until his transfer to Midland.

Jack Beach, former vice president of Independent Exploration Co., Bakersfield, Calif., recently became manager of exploration for Oceanic Oil Co., Los Angeles.

John S. Noel, foreman for Texas Eastern Transmission Corp., Uniontown, Pa., has joined Transcontinental Gas Pipe Line Corp. at Exton, Pa., as district superintendent.

Don W. Gard, Jack R. Easton, and **H. M. Corkum,** chemical engineers, have joined the engineering staff of Canadian Oil Cos., Ltd., at Petrolia and Froomfield, Ont.

Paul A. Weirich, formerly pārty chief for Phillips Petroleum Co. at Lander, Wyo., has joined Gulf Oil Corp. at Denver as geophysical coordinator in the Rocky Mountain region.

Chester R. Richards, assistant district foreman for Sinclair Oil & Gas Co. at Thrall, Kans., has been transferred to Madison, Kans., and promoted to district foreman. Other Sinclair changes include: **Leo J. Endres,** district foreman at Arp, Tex., transferred to Natchez, Miss.; **R. G. Scott,** district foreman at Cleveland, Okla., transferred to Olney, Tex.; **A. J. Cook,** district foreman at Delaware, Okla., transferred to Cleveland; **H. F. Defenbaugh,** division engineer at Oklahoma City, transferred to Delaware as district superintendent; **Julian M. Simpson,** intermediate petroleum engineer at Delaware, transferred to Odessa, Tex.; **R. E. McAvoy,** senior petroleum engineer at Seminole, Okla., promoted to assistant district superintendent there; **Carl E. Most,** assistant district foreman at Wirt, Okla., transferred to Drumright, Okla., as district foreman; **Robert H. Yarger,** senior clerk at Seminole, transferred to Wirt as assistant district foreman; **Robert A. Bonnell,** intermediate petroleum engineer at Odessa, transferred to Midland as senior petroleum engineer; **Don V. Tate,** senior clerk at Tulsa, transferred to Seminole; **Charles M. Rieder,** junior petroleum engineer at Lindsay, Okla., transferred to Arp, Tex.; and **Gene L. Weger,** division engineer at Corpus Christi, Tex., to be transferred to Oklahoma City August 1.

Arthur Lippa, independent oil operator, has moved his offices from Amarillo, Tex., to Denver.

Jack C. Norman, engineer for Amerada Petroleum Corp., has been transferred from Tulsa to Fairbanks, Tex.

Ward M. Clark, former student, has joined Magic Circle Oil Co. at Eureka, Kans., as petroleum engineer.

Jerry L. Williams, formerly a student at Texas A. & M. College, has joined El Paso Natural Gas Co. at Farmington, N. M., as construction engineer.

S. L. Carter, division geologist for Continental Oil Co., and **Melvin E. Thrash,** division land superintendent, will be in charge of the firm's newly established division office at Roswell, N. M.

James F. Drake, Jr., has been appointed assistant to the vice president in charge of product development and product engineering for Gulf Oil Corp. Drake joined Gulf in 1937, collaborating in design and construction of special automotive engines and cars. He left the firm in 1941, rejoining as a lubrication engineer in 1948. He will continue headquarters in Pittsburgh.

J. L. Cramer has been named district geologist for Stanolind Oil & Gas Co.'s newly established northern mountain district office at Billings, Mont. He joined the firm in 1945 as a geological scout at Wichita, Kans. The next year he was advanced to geologist at Jackson, Miss., and was transferred to Casper in 1948, remaining in the Rocky Mountain division since that time.

James L. Minahan has resigned his position with the U. S. Geological Survey at Thermopolis, Wyo., to enter the oil business there as a consulting geological engineer.

W. A. Shoulaw, 1951 graduate of Missouri School of Mines, has joined Dee Miller Drilling Co. at Lawrenceville, Ill., as a geologist.

Harold G. Sehnert, Jr., geologist for Sohio Petroleum Co. at Abilene, Tex., has been promoted to senior geologist in charge of the new Sohio office in Midland, Tex.

Charles C. Vertrees, Jr., 1951 graduate of University of Texas, has joined Continental Oil Co. at Abilene, Tex., as a geologist.

Glen Petrick, formerly district geologist in San Antonio, Tex., for American Republics Corp., has been named vice president and chief geologist of Producers Corp. of Nevada at San Antonio. **Earl Samuel Marie,** geologist in the Houston office of American Republics, has been transferred to San Antonio and promoted to district geologist replacing Petrick.

Marshall M. Frazier, petroleum engineer for Skelly Oil Co., has been transferred from Pampa to Skellytown, Tex.

Angelo T. Chatas, junior technologist for Magnolia Petroleum Corp. at Austin, Tex., has been transferred to Dallas as research engineer.

Henry E. Straw, formerly a student at the University of Texas, has joined The Texas Co. at El Campo, Tex., as petroleum engineer.

S. A. Bradfield has been promoted to assistant manager of transmission for Southern California Gas Co., Los Angeles. **J. L. Oberseider** now has the title of gas-transmission engineer with the company.

John F. Binkley, area engineer for Sunray Oil Corp. at Snyder, Tex., has been transferred to Midland, Tex., as district engineer of the North and West Texas districts.

DEATHS

Hugh J. Walter, 77, prominent oil producer, died July 18 at Bradford, Pa. He was an independent operator and president of H. J. Walter Oil Co., holding oil-field leases in Pennsylvania, Oklahoma, Kansas, and Texas. In recent years he was interested in water-flooding projects near Chanute, Kans., and Nowata, Okla.

John Christopher Curtain, 62, who had been with Union Gas Co. of Canada since 1912, died recently. Prior to his death he was district manager at Merlin, Ont.

Joseph McGill, 76, for many years a Canadian driller in foreign fields, died at Wardsville, Ont., July 9. McGill spent 35 years in Burma, Assam, and Egypt, and following his return to Canada operated an oil property in the Bothwell field.

G. G. Paup, 65, retired employe of United Natural Gas Co., died July 16 at Oil City, Pa.

Lewis R. Owen, 54, manager of the foreign-shipping department of Socony-Vacuum Oil Co., Inc., died July 15 at Port Henry, N. Y. Joining Socony in 1919, Owen served as manager in several Near East countries.

Highlights first half '51

DRILLING for last half is forecast at 23,863 wells and 93,880,000 ft. compared with 20,632 wells and 79,733,000 ft. in first half. Number of rotary rigs operating in United States and Canada is at all-time high.

WILDCAT COMPLETIONS in 1951 will exceed 10,000 wells for first time, 4,677 for first half and 5,523 forecast for last half of the year.

CRUDE PRODUCTION in United States will be up about 13 per cent for the year. Foreign production increased almost 20 per cent in first half.

DEMAND for crude and products will average 7,488,900 bbl. daily for the year, up 10.1 per cent. Last half demand will be up 7.5 per cent.

REFINING operations averaged 6,443,000 bbl. daily for first half, up 1,022,000 bbl. daily or about 19 per cent over same months of 1950.

LIGHT HYDROCARBON production in first 6 months averaged 552,000 bbl. daily for gain of 17 per cent. Increase for year is set at 14 per cent.

NATURAL-GAS sales by utilities were up about 18 per cent. Natural-gas utility construction expenditures will exceed $1,400,000,000 this year.

IMPORTS in the first 6 months increased 9.7 per cent to 895,000 bbl. daily. Exports averaged 335,000 bbl. daily for a gain of 17.1 per cent.

CONSTRUCTION in oil industry reaches new high level. Refining projects, under construction or planned, will add 750,000 bbl. daily to capacity. Field processing-plant capacity will be increased 1,500,000,000 cu. ft. daily. Domestic and foreign pipe lines completed and under way total 18,480 miles.

Midyear Report

Engineering Reference Section

IN ADDITION to furnishing the reader with a well-organized summary of the industry's statistics, this section contains 45 pages of engineering and operating information. Articles cover such varied subjects as applications of the productivity index to oil-field problems, continuous molding of paraffin wax, a review of principles and practice in casing-string design, how centrifugal compressors are operating to compress low-pressure casing-head gas economically, how statistical analysis aids quality control, capillary properties of some limestone cores, gamma-ray logging, well spacing from a geologist's viewpoint, and some new light on centrifugal booster performance and its relation to gas pipe-line capacity.

MIDYEAR REPORT

DRILLING-ACTIVITY FORECAST

. . . Old records fall as operators foresee 23,863 wells drilled in last half

By JOHN C. CASPER

DRILLING operations in the last half of the year will exceed the previous half-year record set during the last 6 months of 1950, according to replies to The Oil and Gas Journal's midyear drilling survey.

The forecast for the last half includes 5,523 wildcats and 18,340 development wells for a total of 23,863 compared with 23,063 in the last half of 1950. This gain of 800 wells represents an increase of 834 wildcat wells and a small decrease of 34 development wells.

The relatively large gain forecast for footage compared with the increase in number of wells indicates deeper drilling than in the last 6 months of 1950. The depth of the average well in the forecast for the last half is 3,934 ft. or 261 ft. deeper than the average for the same period last year. This trend toward deeper wells is due both to deeper drilling in some of the areas and to a shift toward a higher percentage of completions in those states and areas where deeper drilling is common.

Rapid drilling of the Spraberry in West Texas illustrates both reasons for deeper average wells. Spraberry wells at about 7,500 ft. are deeper than the average for West Texas which was 5,303 ft. in 1950. Thus a higher percentage of Spraberry wells will result in an increase in the average well depth for the area. Also, the growth in West Texas has tended to reduce drilling in some of the shallow-producing areas. This increase for deep-well areas combined

Drilling Forecast, Last Half, 1951

	Forecast last half 1951				Change from last half 1950			
	Wildcat wells	Field wells	Total wells	Total footage (thou. ft.)	Wildcat wells	Field wells	Total wells	Total footage (thou. ft.)
Alabama	13	16	29	140	+ 3	+ 1	+ 4	+ 22
Arkansas	52	170	222	760	+ 2	+ 6	+ 8	+ 48
California	306	1,040	1,346	5,520	+ 70	+276	+346	+1,254
Colorado	78	110	188	830	+ 37	+ 73	+110	+ 493
Illinois	387	867	1,254	3,040	— 53	—346	—399	— 708
Indiana	236	365	601	1,060	— 66	—172	—238	— 388
Kansas	537	1,737	2,274	7,600	+ 85	+ 50	+135	+ 843
Kentucky	124	470	594	980	— 2	— 67	— 69	— 245
Louisiana	234	985	1,219	8,130	+ 66	—113	— 47	+ 756
North	114	441	555	2,140	+ 24	—178	—154	— 310
South	120	544	664	5,990	+ 42	+ 65	+107	+1,066
Michigan	172	216	388	960	— 33	— 87	—120	— 265
Mississippi	82	106	188	1,350	+ 19	+ 25	+ 44	+ 310
Montana	42	117	159	410	+ 5	— 33	— 28	— 38
Nebraska	68	71	139	460	+ 4	— 3	+ 1	— 21
New Mexico	82	360	442	2,220	+ 41	+108	+149	+ 885
New York	0	268	268	380		— 53	— 53	— 82
Ohio	27	467	494	1,050	+ 17	— 76	— 59	— 86
Oklahoma	513	2,405	2,918	10,680	+ 95	— 31	+ 64	— 117
Pennsylvania	13	854	867	1,610	+ 11	+ 12	+ 23	+ 182
Texas	2,411	7,065	9,476	43,500	+534	+320	+854	+5,880
North Central (7-B, 9)	997	1,856	2,853	9,180	+249	— 14	+235	+1,846
West (7-C, 8)	482	2,497	2,979	16,130	+113	+163	+276	+1,892
Panhandle (10)	15	371	386	1,210	+ 5	— 33	— 28	— 86
Eastern (5, 6)	142	463	605	2,700	+ 35	+ 12	+ 47	+ 158
Gulf Coast (2, 3)	416	991	1,407	8,690	+ 87	+115	+202	+1,433
Southwest (1, 4)	359	887	1,246	5,590	+ 45	+ 77	+122	+ 637
West Virginia	8	305	313	890	— 13	— 5	— 18	— 40
Wyoming	75	332	407	2,030	— 8	+ 69	+ 61	+ 373
Miscellaneous	63	14	77	280	+ 20	+ 12	+ 32	+ 106
Total United States	5,523	18,340	23,863	93,880	+834	— 34	+800	+9,162

DRILLING BY TYPE OF OPERATOR

	30 large operators	All other operators	Total industry
First half actual—			
Wildcats	648	4,031	4,677
Field wells	4,345	11,610	15,955
Total	4,991	15,641	20,632
Ratio wildcats to total	.129	.258	.226
Last half forecast—			
Wildcats	1,149	4,374	5,523
Field wells	6,039	12,301	18,340
Total	7,188	16,675	23,863
Ratio wildcats to total	.160	.262	.231
Total year 1951 (first half actual plus last half forecast)—			
Wildcats	1,795	8,405	10,200
Field wells	10,384	23,911	34,295
Total	12,179	32,316	44,495
Ratio wildcats to total	.147	.260	.229
Year 1950—			
Wildcats	1,014	7,540	8,554
Field wells	8,211	26,514	34,725
Total	9,225	34,054	43,279
Ratio wildcats to total	.110	.221	.198

with a decrease in shallow drilling will increase the depth of the nation's average well.

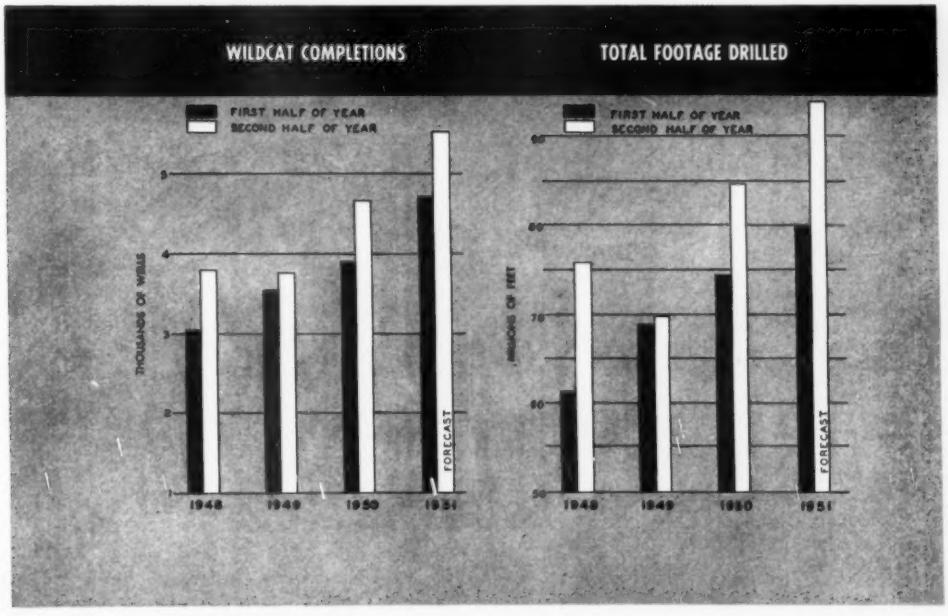
The revised forecast for the year, compiled from actual completion data for the first half and the forecast for the last half, calls for 44,495 wells and 173,613,000 ft. of hole. Changes in operator's drilling plans during the first half of the year have added 652 wells to the total forecast at the first of the year. However, these changes in drilling programs have resulted in greater shifts by areas than in additions to the national total. The forecast for Texas was increased about twice as much as the gain for the country as a whole.

A check on reports of nine large operators in West Texas shows that they now plan to drill 60 per cent more wells in that area than was shown in their programs at the first of the year.

The current forecast indicates the influence of steel allocations on wildcat drilling. Exploratory wells now represent 22.9 per cent of total wells estimated for the year compared with 19.8 per cent for 1950 and 20.9 per cent in the original forecast for 1951. The ratio for the first half of 1950 was 22.6 per cent.

FORECAST FOR YEAR 1951
(First half actual plus last half forecast)

	Wildcat wells	Field wells	Total wells	Total footage (thou. ft.)
Alabama	22	37	59	292
Arkansas	96	312	408	1,406
California	545	1,877	2,422	9,801
Colorado	131	159	290	1,358
Illinois	731	1,608	2,339	5,759
Indiana	422	680	1,122	1,981
Kansas	1,066	3,305	4,371	14,643
Kentucky	250	875	1,125	1,898
Louisiana	391	1,822	2,213	14,598
North	196	871	1,067	4,106
South	195	951	1,146	10,492
Michigan	338	409	747	1,868
Mississippi	143	194	337	2,391
Montana	55	196	251	615
Nebraska	125	137	262	922
New Mexico	132	622	754	3,710
New York	0	560	560	792
Ohio	46	868	914	1,939
Oklahoma	978	4,665	5,643	20,736
Pennsylvania	16	1,607	1,623	2,995
Texas	4,447	13,149	17,596	80,067
North Central	1,869	3,479	5,348	16,953
West	876	4,554	5,430	29,339
Panhandle	27	699	726	2,256
Eastern	260	938	1,198	5,368
Gulf Coast	746	1,797	2,543	15,617
Southwest	669	1,682	2,351	10,534
West Virginia	16	569	585	1,691
Wyoming	121	617	738	3,706
Miscellaneous	109	18	127	445
Total U. S.	10,200	34,295	44,495	173,613



MIDYEAR REPORT

WELL-COMPLETION REPORT

. . . Operators drill nearly 80,000,000 ft. of hole during first half—a new record

By POLLY DE ARMOND

TOTAL completions for the first 6 months numbered 20,632, a gain of 416 wells or 2.1 per cent over the first half of 1950. Footage drilled totaled 79,732,958 ft., a jump of 5,163,247 ft. or 6.9 per cent over last year. Both of these figures represent new all-time highs for comparable periods of any year in the history of the oil industry.

Significantly, in January operators reported to The Oil and Gas Journal that they planned to complete more new wells during this year than ever before, and if they continue to drill at this midyear record rate, there is every indication that the tremendous program scheduled for 1951 will be fulfilled.

Two reasons stand out as bases for the increase in activity to supply the strong demand for all products: the unheard-of pace of exploratory ventures with emphasis on "rank" wildcatting (most notable example, Amerada Petroleum Corp. 1 Iverson, oil strike in North Dakota), and accelerated work in many deeper already-established producing districts.

During the past few months it was apparent that a big year was in prospect. Activity in the combined areas of the general increase (Texas, Oklahoma, Kansas, the Rockies, and California) climbed from 66.3

Summary of Completed Wells, First 6 Months

	Total comp.	Oil	Gas	Dry	Service	Footage (thou. ft.)	Total Jan.-June 1950
Alabama	30	15	0	15	0	152	18
Arkansas	186	108	2	76	0	646	193
California	1,076	786	17	269	4	4,281	829
Colorado	111	44	5	62	0	528	21
Florida	0	0	0	0	0	0	11
Illinois	1,085	421	3	654	7	2,719	1,170
Indiana	521	174	8	336	3	921	695
Kansas	2,097	1,010	182	881	24	7,043	1,871
Kentucky	531	231	58	242	0	918	487
Louisiana	994	541	79	373	1	6,468	1,187
North	512	265	62	184	1	1,966	618
South	482	276	17	189	0	4,502	569
Michigan	359	106	14	230	9	908	389
Mississippi	149	64	6	79	0	1,041	169
Montana	92	65	1	26	0	205	83
Nebraska	123	49	8	66	0	462	33
New Mexico	312	154	83	75	0	1,490	314
New York	292	147	0	0	145	412	336
Ohio	420	144	98	143	35	889	474
Oklahoma	2,725	1,535	120	1,014	56	10,056	2,605
Pennsylvania	756	340	111	27	278	1,385	737
Texas	8,120	5,006	329	2,777	8	36,567	7,963
Eastern (5, 6)	593	389	11	192	1	2,668	606
North Central (7-B, 9)	2,495	1,230	25	1,234	6	7,773	2,444
Panhandle (10)	340	183	122	34	1	1,046	475
West (7-C, 8)	2,451	1,924	5	522	0	13,209	2,302
Southwest (1, 4)	1,105	636	54	415	0	4,944	1,033
Gulf Coast (2, 3)	1,136	644	112	380	0	6,927	1,103
Utah	11	1	0	10	0	35	4
West Virginia	272	34	178	60	0	801	321
Wyoming	331	215	14	102	0	1,676	269
Miscellaneous	39	4	15	20	0	130	37
Jan.-June 1951	20,632	11,194	1,331	7,537	570	79,733	
Jan.-June 1950	20,216	11,693	1,351	6,565	607	74,570	

COMPLETIONS BY STATES—DEPTH CLASSIFICATIONS

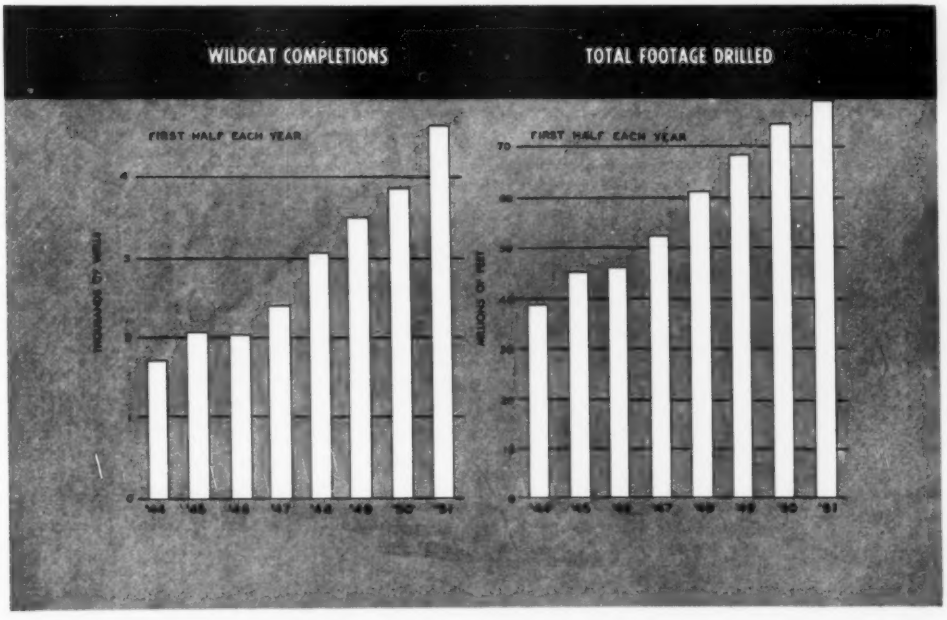
	Under 2,500 ft.	2,500-5,000 ft.	5,000-7,500 ft.	7,500-10,000 ft.	10,000-12,500 ft.	Over 12,500 ft.
Alabama	0	16	8	5	1	0
Arkansas	51	110	11	12	2	0
California	343	451	165	74	36	7
Colorado	15	24	68	3	1	0
Florida	0	0	0	0	0	0
Illinois	413	671	1	0	0	0
Indiana	432	89	0	0	0	0
Kansas	259	1,820	17	1	0	0
Kentucky	445	86	0	0	0	0
Louisiana	187	230	142	175	224	36
North	175	193	86	45	13	0
South	12	37	56	130	211	36
Michigan	197	160	2	0	0	0
Mississippi	2	17	78	37	13	2
Montana	70	21	1	0	0	0
Nebraska	31	78	14	0	0	0
New Mexico	76	123	48	45	16	4
New York	292	0	0	0	0	0
Ohio	236	180	4	0	0	0
Oklahoma	811	1,300	453	82	77	2
Pennsylvania	674	47	35	0	0	0
Texas	2,045	2,941	2,184	744	170	36
Eastern	114	265	143	65	4	2
North Central	1,069	1,075	349	2	0	0
Panhandle	39	295	2	4	0	0
West	429	620	1,052	233	86	31
Southwest	305	341	314	132	13	0
Gulf Coast	89	345	324	308	67	3
Utah	7	2	1	0	0	1
West Virginia	119	142	11	0	0	0
Wyoming	19	181	93	28	8	2
Miscellaneous	15	18	4	0	1	1
Total U. S.	6,739	8,707	3,340	1,206	549	91

SUMMARY OF DRILLING METHODS, FIRST 6 MONTHS

	Total comp.	Rotary comp.	Cable comp.
Alabama	30	30	0
Arkansas	186	184	2
California	1,076	1,074	2
Colorado	111	111	0
Florida	0	0	0
Illinois	1,085	948	137
Indiana	521	446	75
Kansas	2,097	1,742	355
Kentucky	531	396	135
Louisiana	994	994	0
North	512	512	0
South	482	482	0
Michigan	359	*103	256
Mississippi	149	148	1
Montana	92	79	13
Nebraska	123	79	44
New Mexico	312	*287	25
New York	292	0	292
Ohio	420	14	406
Oklahoma	2,725	2,286	439
Pennsylvania	756	0	756
Texas	8,120	7,853	267
Eastern	593	593	0
North Central	2,495	2,357	138
Panhandle	340	337	3
West	2,451	*2,328	123
Southwest	1,105	1,102	3
Gulf Coast	1,136	1,136	0
Utah	11	11	0
West Virginia	272	0	272
Wyoming	331	331	0
Miscellaneous	39	7	32
Total	20,632	17,123	3,509

*Incl. wells drilled by rotary and finished by cable tools.

per cent of the 6-month total in 1950 to reach 71.2 per cent of this year's figure. Increased operations brought three basins of the Rocky Mountain region into the limelight—Julesburg-Denver basin (reaching clear into western Kansas), Williston basin, and Uintah basin. In the Southwest, an unpredicted drilling campaign was opened in Texas' Spraberry areas, Oklahoma's Elk City condensate field and Golden Trend section continued extensive development, exploration history was being made throughout Kansas, and Nebraska (particularly the western portion) was growing rapidly. Drilling in California rose steadily to meet the West Coast's demand for crude. In the southern section of the nation a deep-drilling race



DEVELOPMENT WELL COMPLETIONS, FIRST 6 MONTHS

	Comp.	Oil	Gas	Dry and Service	Footage (thou. ft.)
Alabama	21	14	0	7	91
Arkansas	142	100	2	40	460
California	837	782	16	59	3,301
Colorado	58	41	2	15	286
Florida	0	0	0	0	0
Illinois	741	381	3	357	1,872
Indiana	315	150	6	159	560
Kansas	1,568	901	173	494	5,030
Kentucky	405	214	57	134	680
Louisiana	837	511	75	251	5,250
North	430	256	59	115	1,560
South	407	255	16	136	3,690
Michigan	193	99	10	84	517
Mississippi	88	55	6	27	592
Montana	79	65	1	13	161
Nebraska	66	44	7	15	243
New Mexico	262	148	76	38	1,243
New York	292	147	0	145	412
Ohio	401	143	94	164	926
Oklahoma	2,260	1,437	105	718	8,138
Pennsylvania	753	340	110	303	1,368
Texas	8,084	4,613	271	1,200	28,901
Eastern	475	381	11	83	2,179
North Central	1,623	1,054	17	552	4,838
Panhandle	328	182	122	24	976
West	2,057	1,837	1	219	10,750
Southwest	795	585	41	169	3,505
Gulf Coast	806	574	79	153	4,653
Utah	0	0	0	0	0
West Virginia	264	34	173	57	780
Wyoming	285	209	14	62	1,429
Miscellaneous	4	3	0	1	4
Jan.-June 1951	15,955	10,411	1,201	4,343	60,084
Jan.-June 1950	16,351	11,066	1,245	4,020	59,035

WILDCAT COMPLETIONS, FIRST 6 MONTHS

	Comp.	Oil	Gas	Dry	Footage (thou. ft.)
Alabama	9	1	0	8	61
Arkansas	44	8	0	36	186
California	239	24	1	214	980
Colorado	53	3	3	47	262
Florida	0	0	0	0	0
Illinois	344	40	0	304	847
Indiana	206	24	2	180	861
Kansas	529	109	9	411	2,613
Kentucky	128	17	1	108	258
Louisiana	157	30	4	123	1,218
North	82	9	3	70	406
South	75	21	1	53	812
Michigan	166	7	4	155	391
Mississippi	61	9	0	52	449
Montana	13	0	0	13	44
Nebraska	57	5	1	51	219
New Mexico	50	6	7	37	247
New York	0	0	0	0	0
Ohio	19	1	4	14	63
Oklahoma	465	98	15	352	1,918
Pennsylvania	3	0	1	2	17
Texas	2,036	393	58	1,585	9,866
Eastern	118	8	0	110	489
North Central	872	176	8	688	2,935
Panhandle	12	1	0	11	70
West	394	87	4	303	2,459
Southwest	310	51	13	246	1,439
Gulf Coast	330	70	33	227	2,274
Utah	11	1	0	10	35
West Virginia	8	0	5	3	41
Wyoming	46	6	0	40	247
Miscellaneous	35	1	15	19	126
Jan.-June 1951	4,677	783	130	3,764	19,649
Jan.-June 1950	3,865	607	106	3,152	15,535

was on. Initiation of large secondary-recovery programs started many new ventures, and the number of active rigs was consistently high.

Wildcat drilling also hit a new high for any midyear. Wells increased 812 or 21 per cent, compared with last year's previous record. Total footage of some 19,649,000 ft. was up more than 4,000,000 ft. or 26.5 per cent.

Development completions lagged behind January-June of last year. Total wells were down 396 or 2.4 per cent; however, total footage (rounded to 60,084,000 ft.) increased more than 1,000,000 ft. or 1.8 per cent.

WELL COMPLETIONS BY MONTHS

Wildcat Completions

	Jan.	Feb.	Mar.	Apr.	May	June
Oil	128	84	140	118	170	143
Gas	21	14	28	16	31	20
Dry	599	466	595	627	790	687
Total	748	564	763	761	991	850

Development Completions

Oil	1,839	1,431	1,754	1,651	1,904	1,832
Gas	207	203	211	137	229	214
Dry	738	526	709	695	836	839
Total	2,784	2,160	2,674	2,483	2,969	2,885

Total Completions

Oil	1,967	1,515	1,894	1,769	2,074	1,975
Gas	228	217	239	153	260	234
Dry	1,337	992	1,304	1,322	1,626	1,526
Total	3,532	2,724	3,437	3,244	3,960	3,735

By Depth Classifications

Depth (ft.)						
Under 2,500	1,154	838	1,049	1,124	1,286	1,290
2,500- 5,000	1,508	1,176	1,436	1,341	1,676	1,570
5,000- 7,500	579	467	573	518	623	580
7,500-10,000	208	149	230	169	244	206
10,000-12,500	74	81	132	76	109	77
Over 12,500	9	15	17	16	22	12

Average depths for all wells increased from 3,689 ft. per well in 1950 to 3,865 ft. per well this year. The average depth of wildcats so far in 1951 jumped to 4,201 ft. per well compared with 4,019 ft. per well the preceding year, and development-well average depth was 3,766 ft. against 3,610 ft. during the first half of 1950.

Almost 89 per cent of all completions were accounted for by the same 10 states as last year, with a few changes in their positions: Texas, with 8,120 wells or 39.4 per cent of the 6-month total; Oklahoma, noting 2,725 completions or 13.2 per cent of the total; Kansas, completing 2,097 wells or 10.2 per cent; Illinois, having 1,085 completions or 5.3 per cent; California, reporting 1,076 wells or 5.2 per cent; Louisiana, showing 994 completions or 4.8 per cent of all wells; Pennsylvania, with 756 wells or 3.7 per cent; Kentucky, recording 531 completions or 2.6 per cent; Indiana, having 521 wells or 2.5 per cent; Ohio, with 420 wells or 2 per cent of the total. In 1950 the states ranked in the following order: Texas, Oklahoma, Kansas, Louisiana, Illinois, California, Pennsylvania, Indiana, Kentucky, and Ohio.

SERVICE WELL COMPLETIONS BY MONTHS

	Pennsylvania	New York	Oklahoma	Other states	Total U.S.
January	31	17	3	14	65
February	29	14	8	9	58
March	41	22	5	14	82
April	50	26	11	15	102
May	59	31	11	16	117
June	68	35	20	23	146
Total	278	145	56	91	570

DISTILLATE WELL COMPLETIONS BY MONTHS

	Texas	Louisiana	Oklahoma	Other states	Total U.S.
January	23	11	6	1	41
February	16	5	9	2	31
March	25	6	17	1	49
April	14	4	4	3	25
May	20	10	8	2	40
June	19	8	10	1	38
Total	117	44	53	10	224

MIDYEAR REPORT

ACTIVE ROTARY RIGS

. . . First half ends with more than 2,700 rotaries busy in U. S. and Canada

By NEIL WILLIAMS

THE first half of the year ended with over-all drilling activity in the United States and western Canada at a record level. At that time more than 2,700 rotary rigs were operating in the region. This not only was the greatest aggregation of active drilling rigs ever reported but exceeded by more than 200 rigs the 1950 peak of activity last December, an all-time "high" up to that time.

Although much now depends on the extent to which present short supplies of tubular goods and other necessary equipment are made available, drilling normally increases steadily during the summer and autumn months to annual peaks in activity late in the year, usually in December. If seasonal trends in drilling exploration and development of previous years are followed, the number of active rigs can be expected to rise much higher the last 6 months.

At the 1950 peak late last December there were 2,521 rigs in operation, nearly 200 more than at the midyear count. With a corresponding increase in drilling this year, there should be more than 2,900 rigs running by next December. New exploration and development in prospect for the remainder of the year generally is believed more than enough to use this number of rigs if equipment can be obtained.

Since the 1950 peak there has been the normal, early-year seasonal decline in drilling activity in which the number of operating rigs dropped to a "low" of 2,119 rigs, reported during the first week of February. This low, however, was nearly 200 rigs higher than the low figure of 1950. Starting the year at a record high level, the number of active rigs has continued consistently higher than for corresponding periods last year. At midyear there were more than 384 active rigs than at the same time last year.

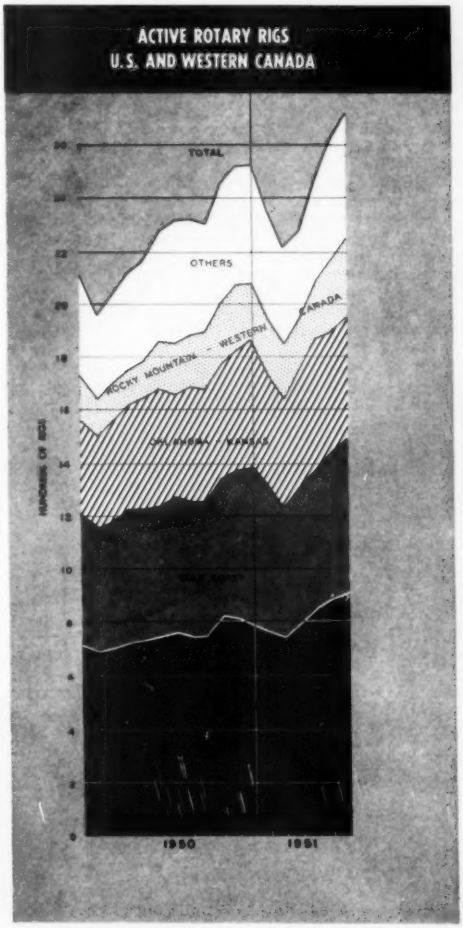
Of the total number of rigs operating at midyear, more than 900 were in the West Texas-New Mexico area. This number, an all-time record for the area, represented an increase of more than 100 rigs since the first of the year, due largely to continued development of "reef" production through Scurry and adjoining counties and spread of exploration along the Spraberry trend play farther west.

DISTRIBUTION OF ACTIVE ROTARY RIGS

(United States and Western Canada)

Area—	1951 peak* Rigs	1951 peak* % of total	1950 peak* Rigs	1950 peak* % of total	1949 peak* Rigs	1949 peak* % of total
Gulf Coast	590	21.7	603	23.9	539	23.6
W. Tex.-N. M.	904	33.3	787	31.2	709	31.0
Ark.-N. La.-E. Tex.	158	5.8	165	6.5	159	7.0
Oklahoma	300	11.1	309	12.3	262	11.5
Kansas-S. Nebraska	158	5.8	161	6.4	144	6.3
Illinois-Eastern	148	5.5	138	5.5	150	6.6
Rocky Mountains	158	5.8	114	4.5	90	3.9
Pacific Coast	156	5.8	131	5.2	148	6.5
Total U. S.	2,572	94.8	2,407	95.5	2,201	96.4
Western Canada	141	5.2	114	4.5	83	3.6
Total	2,713	100.0	2,521	100.0	2,284	100.0

*Dates of peaks: 1951, June 30; 1950, December 11; 1949, December 12.



MIDYEAR REPORT

CRUDE-OIL PRODUCTION

. . . Production continues up and up, now exceeding 6 million barrels daily

By PHILIP C. INGALLS

EVERY month so far this year saw a new all-time high in monthly crude-oil production established.

From the record-breaking daily average of 5,907,000 bbl. in January, production of crude oil and condensate produced on leases in the United States steadily climbed to an average of 6,182,000 bbl. daily in June.

Average daily production for the first 6 months of 1951 was 6,062,000 bbl. This average crude production was 1,153,000 bbl. per day more than the average daily production for the first 6 months of 1950.

June 1951 production was 463,000 bbl. daily higher than December 1950 production and 282,000 bbl. daily more than last year's monthly high of 5,900,000 bbl. daily in October, which established an all-time high at the time.

Right now every indication points to the greatest producing year in this country's history. If current forecasts based on these indications materialize, crude production will end up this year almost 13 per cent higher than 1950's and 10.5 per cent higher than the previous record year of 1948 when daily average production was 5,514,000 bbl.

This record-breaking production rate is the continuation of an upward trend started August 1949 after daily average production had dropped to 4,695,000 bbl. daily in July, the lowest month of production since January 1947 when 4,672,000 bbl. per day was produced.

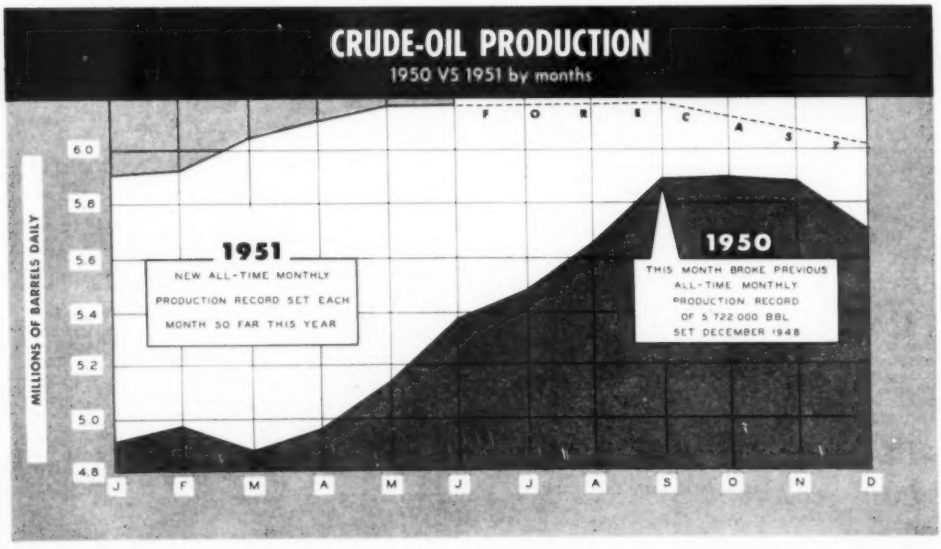
Reasons for Production Climb

What's responsible for these ever-new production highs?

Demand for refined products reached an all-time high during the first quarter of this year as a result of increased needs of the military, accelerated industrial activity, more cars on the road, more railroads converting from coal to oil, and more home-heating systems shifting from coal to oil.

Crude production is not as flexible as refinery throughput and as a result crude-oil stocks were drawn on during the first quarter to the extent that they were lowered to 234,000,000 bbl. by the end of March 1951. This was the lowest level that they had been since the peak of 275,000,000 bbl. was reached in mid-1949.

To build up crude stocks to 250,000,000 bbl., a minimum level for working stock according to estimates of national defense officials, meant that production had to increase at a rate that would not only meet second-quarter refinery runs, but would replace



that crude drawn from stocks during the first quarter while production was lagging behind demand.

Stocks at the end of June were back at 250,000,000 bbl. which meant that the second-quarter increase in production was greater than demand for domestic crude by 16,000,000 bbl., or 175,000 bbl. daily.

The minimum level of crude stocks has been reached, and though crude inventories may continue to be built up, it appears probable that future increases will be at a decelerating rate so that production may have reached its current peak and be due for a leveling off, or perhaps a slight decline, for the remainder of the year. The forecast of crude production is included in the discussion beginning on page 196. The forecast figures are shown on an accompanying chart.

As shown on the opposite page, production at the beginning of last year had declined to below 5,000,000 bbl. daily. Though there was a sharp rise beginning in April, the poor start kept the first 6-month average comparatively low.

Total production for the first 6 months of this year has been 1,097,000,000 bbl., almost 185,000,000 bbl. more than for a like period in 1950. In daily average production that's about 1,020,000 bbl.

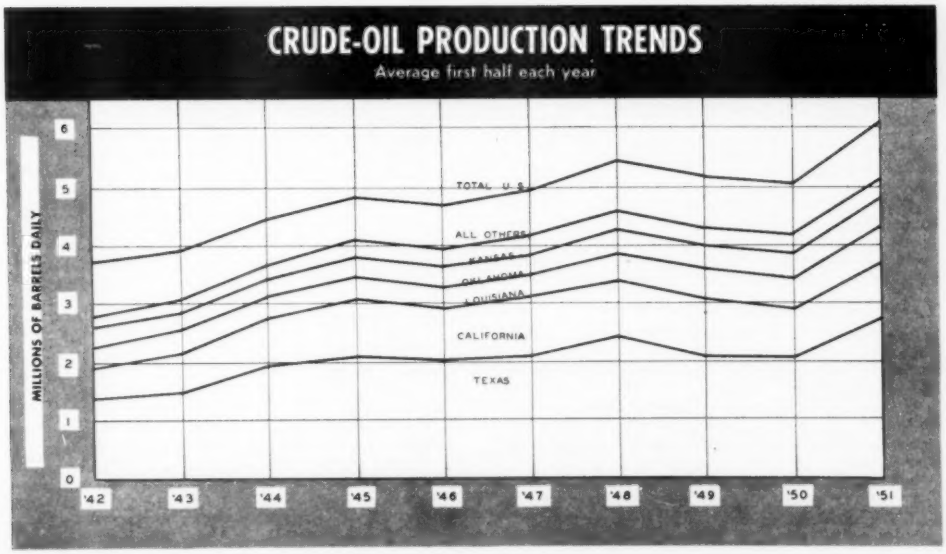
Texas' daily average production of 2,700,000 bbl. for the first half of 1951 averaged 668,000 bbl. daily more than it did during last year's first half. This volume of production is 273,000 bbl. daily more than Texas' previous first 6 months' record of 2,427,000 bbl. daily set back in 1948.

The increase of production in Texas accounted for over 65 per cent of the total increase of 1,020,000 bbl. daily, indicating that as in the past, it is to the big state's reserves that this country must turn for the bulk of its increases in production.

United States Crude-Oil Production—First Half Year

(Thousands of barrels daily)

	1951	1950	1949	1948	1947	1946	1945	1944	1943	1942
Alabama	2.8	1.8	1.2	1.3	1.0	1.1	0.4	0.1		
Arkansas	81.8	85.8	84.8	85.7	80.2	77.0	80.1	80.1	73.6	73.1
California	962.9	866.6	938.2	940.2	903.6	854.8	916.0	829.9	772.3	632.6
Colorado	74.7	60.3	63.7	45.7	38.5	27.5	10.5	7.9	6.0	5.7
Florida	1.6	1.1	1.3	0.8	0.5	0.2	0.1	0.1		
Illinois	163.6	170.4	175.5	174.0	185.9	208.5	207.1	214.8	231.3	319.4
Indiana	26.9	26.7	24.3	17.2	17.1	18.7	13.1	14.1	14.9	19.7
Kansas	311.1	286.1	288.0	297.1	280.7	257.6	268.7	272.3	302.3	249.2
Kentucky	28.0	26.2	23.2	24.1	25.3	29.7	27.4	23.3	18.7	11.7
Louisiana	636.5	547.6	520.8	483.0	424.1	379.7	356.9	353.3	330.9	319.5
Michigan	39.7	44.7	44.6	44.9	42.8	47.2	48.2	51.9	58.4	57.2
Mississippi	102.9	101.3	108.5	120.2	89.4	57.8	51.1	42.1	54.9	87.6
Montana	23.9	21.8	25.8	24.8	23.2	24.8	23.3	23.8	20.6	22.0
Nebraska	7.9	2.4	0.6	0.6	0.6	0.9	0.9	1.1	2.1	3.9
New Mexico	140.7	128.6	132.9	128.1	105.6	99.1	104.3	111.5	101.1	84.1
New York	11.4	11.5	12.3	12.7	13.0	13.4	12.5	13.0	14.1	14.9
Ohio	8.7	9.3	9.6	9.5	8.1	8.0	7.7	8.2	9.0	9.8
Oklahoma	504.0	417.7	419.1	411.3	375.7	375.1	376.7	353.5	341.7	395.7
Pennsylvania	31.8	31.7	32.1	34.9	34.6	35.6	34.7	40.1	44.7	49.8
Texas	2,700.9	2,032.7	2,106.8	2,427.0	2,146.0	2,055.3	2,161.8	1,950.4	1,429.1	1,306.4
Utah	3.5	3.2	0.8							
West Virginia	7.5	7.9	7.5	7.2	6.9	8.3	8.0	8.6	9.4	9.9
Wyoming	169.0	157.1	127.1	145.9	116.1	105.6	102.7	88.9	91.4	89.6
Miscellaneous	0.2	0.2	0.3	0.2	0.4	0.2	0.1	0.1	0.1	0.1
Total United States	6,062.0	5,042.5	5,149.0	5,436.4	4,918.3	4,686.1	4,812.3	4,469.1	3,926.4	3,781.9



MIDYEAR REPORT

SUPPLY-DEMAND FORECAST

. . . Last-half demands will continue to exceed those previously forecast

By E. T. KNIGHT*

FORECASTS

Total demand will average 7,550,000 bbl. daily for last half of 1951, up 7.5 per cent from last year.

Crude production for last half is estimated at 6,128,000 bbl. daily, up 6.5 per cent.

Refinery runs for last half are projected at 6,449,000 bbl. daily, up 6.6 per cent.

Middle-distillate demand will climb to 2,310,000 bbl. daily by first quarter of 1952.

Gasoline demand for the year will be 10.7 per cent greater than in 1950.

PETROLEUM activity for 1951 will be about 10 per cent higher than last year, and 5 per cent higher than appeared likely last January. On the basis of what actually happened during the first 6 months of 1951 and definite assumptions concerning conditions in the last half, it appears that total demands on the United States oil industry will average approximately 7,489,000 bbl. per day for the year as a whole.

How the supply-and-demand picture has changed since January is highlighted in Table 1, which compares the present outlook with the forecast published in The Oil and Gas Journal January 25, 1951.

Looking ahead in oil is particularly difficult right now because current world conditions may have unpredictable effects on the trend of the general economy in this country.

The uncertain future of the oil industry in some Middle East nations, and the recent proposals for a negotiated peace in Korea will probably have relatively more immediate repercussion on the oil industry than on other enterprises in the United States.

Iranian Situation Poses Problem

The solution to the Iranian problem is not clear, and until some settlement is made the effect upon the Western Hemisphere oil economy, and the United States in particular, cannot be adequately appraised. In this matter this forecast considers that any interruption in the flow of Iranian oil will be short lived regardless of who ultimately operates the Iranian oil industry.

The ending of hostilities in Korea would reduce, for the time being at least, the demands on the United States oil industry. However, it has been assumed that the military petroleum requirements will exceed their present rates—for combat use if necessary, otherwise, for training and stock piling.

The difficulty of subjecting these uncertainties to statistical analysis is obvious, and therefore the forecasts here presented contain an unusual amount of pure speculation and may be altered greatly as future trends in world affairs become more clearly defined.

The assumptions which were employed in this reappraisal of oil industry activities during 1951 (and the first quarter of 1952) are:

1. Normal temperatures will be experienced during the coming winter.
2. Industrial activities will continue upwards throughout the remainder of the period, with perhaps some minor retardation during the immediate 3 months.
3. Supplies will be adequate to make any form of rationing unnecessary.

On the basis of the foregoing, petroleum demands

TABLE 1—COMPARISON OF FORECASTS OF SUPPLY AND DEMAND FOR PETROLEUM PRODUCTS, YEAR 1951
(Barrels daily)

	Forecast 1-25-51	Current forecast	Per cent current forecast over 1-25-51 forecast
Domestic demands:			
Motor fuel	2,951,700	3,027,100	2.6
Kerosine	339,100	354,400	4.5
Distillate fuels	1,173,400	1,238,200	5.5
Residual fuels	1,499,500	1,611,200	7.4
Lubricants	108,300	118,000	9.0
Wax	8,300	9,800	18.1
All other and losses	773,200	828,900	
Total domestic	6,853,500	7,187,600	4.9
Exports:			
Crude oil	75,000	97,300	29.7
Products	186,400	204,000	9.4
Total exports	261,400	301,300	15.3
Total demand	7,114,900	7,488,900	5.3
Supplies:			
Crude-oil production	5,789,400	6,092,800	5.6
Natural gasoline and related products	527,500	567,200	7.5
Imports	873,600	901,500	3.2
Total supply	7,170,500	7,561,500	5.5
Stock change—Crude oil and products	+55,600	+72,600	

*Petroleum economist, Atlantic Refining Co.

Table 2—Demand and Supply of Petroleum Products, 1951

(Barrels daily)

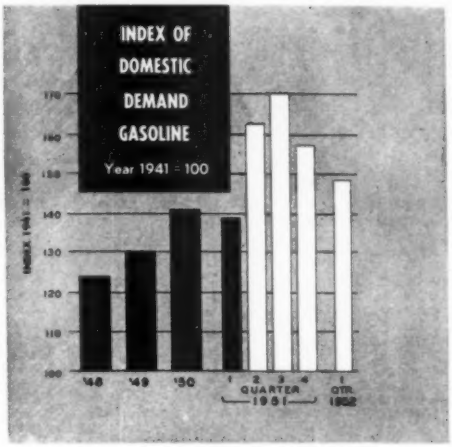
Demands—	First quarter Actual	Per cent inc. over 1950	Second quarter Estimated	Per cent inc. over 1950	Third quarter Forecast	Per cent inc. over 1950	Fourth quarter Forecast	Per cent inc. over 1950	Year—1951 Forecast	Per cent inc. over 1950
Motor fuel	2,731,800	14.9	3,210,000	9.8	3,335,000	10.0	3,084,000	9.2	3,091,800	10.7
Domestic	2,667,980	14.8	3,140,000	10.0	3,270,000	10.2	3,024,000	10.1	3,027,100	11.1
Exports	63,820	15.8	70,000	— 2.0	65,000	0.4	60,000	—19.7	64,700	—3.7
Kerosine	473,630	9.7	255,000	22.1	285,000	9.1	445,000	3.0	359,300	9.4
Domestic	469,000	10.3	250,000	21.6	280,000	9.4	440,000	3.7	354,400	9.7
Exports	4,630	—28.5	5,000	52.0	5,000	—1.6	5,000	—33.7	4,900	—12.5
Distillate fuels	1,724,470	20.6	960,000	14.3	935,000	9.4	1,480,000	10.3	1,273,300	14.1
Domestic	1,694,020	21.5	920,000	12.5	900,000	9.7	1,445,000	10.2	1,238,200	14.5
Exports	30,450	—14.9	40,000	29.9	35,000	2.4	35,000	— 3.1	35,100	2.0
Residual fuels	1,826,090	6.4	1,550,000	10.0	1,500,000	4.3	1,725,000	2.9	1,649,500	5.8
Domestic	1,787,690	6.8	1,510,000	10.9	1,460,000	4.8	1,690,000	3.5	1,611,200	6.4
Exports	38,400	— 8.1	40,000	—15.6	40,000	—10.9	35,000	—20.0	38,300	—13.9
Lubricants	157,210	19.6	158,000	11.1	162,000	4.5	152,000	— 0.5	157,300	8.1
Domestic	114,950	21.9	118,000	13.2	122,000	5.1	117,000	5.1	118,000	10.8
Exports	42,260	13.5	40,000	5.2	40,000	2.3	35,000	—15.7	39,300	0.9
Wax	14,130	35.9	12,000	7.2	13,000	— 0.8	13,000	— 5.5	13,100	7.9
Domestic	10,040	34.5	9,000	6.6	10,000	5.4	10,000	— 0.3	9,800	10.5
Exports	4,090	36.3	3,000	9.5	3,000	—17.1	3,000	—19.6	3,300	0.9
Asphalts, domestic*	103,450	35.6	200,000	20.8	270,000	10.2	159,000	3.0	183,500	14.1
Road oils, domestic*	4,720	21.7	20,000	4.7	40,000	— 0.7	12,000	0.0	19,300	2.1
L.P.G. (incl. L.R.G.), domestic*	301,150	30.5	275,000	31.1	275,000	24.2	315,000	16.4	291,500	25.0
Misc. products and losses	304,040	17.3	327,000	11.7	340,000	4.1	320,000	6.0	322,900	9.4
Domestic†	287,660	15.3	310,000	11.2	320,000	3.4	300,000	5.5	304,500	8.5
Exports	16,380	66.5	17,000	20.9	20,000	17.1	20,000	13.5	18,400	25.4
Crude oil	96,190	—14.2	153,000	1.3	140,000	—10.5	120,000	—18.2	127,400	—10.1
Domestic—as such and losses	7,030	—82.5	33,000	—34.9	40,000	—31.8	40,000	11.2	30,100	—35.1
Exports	89,160	23.9	120,000	19.5	100,000	2.2	80,000	—27.7	97,300	2.1
Total demand for all oils	7,736,880	14.1	7,130,000	11.7	7,275,000	8.2	7,825,000	6.8	7,488,800	10.1
Domestic	7,447,890	14.3	6,785,000	11.9	6,967,000	8.6	7,552,000	8.1	7,187,800	10.6
Exports	288,190	9.7	335,000	8.7	308,000	0.5	273,000	—16.9	301,000	— 0.8
Supplies—										
Stock changes	—382,230	....	+450,000	....	+350,000	....	—230,000	....	+72,880	....
Crude oil	—162,660	....	+160,000	....	+ 72,000	....	+ 15,000	....	+21,700	....
Products	—130,570	....	+290,000	....	+278,000	....	—245,000	....	+50,990	....
Total new supply	7,453,650	20.1	7,270,000	17.2	7,625,000	8.8	7,595,000	4.0	7,561,100	12.1
Imports	925,270	15.5	960,000	3.8	990,000	5.5	940,000	2.1	901,500	6.4
Crude oil	483,770	5.8	530,000	8.9	530,000	3.2	520,000	3.8	513,600	6.3
Products	442,100	29.6	390,000	— 5.1	360,000	9.0	420,000	0.5	387,900	7.7
Domestic supply	6,527,780	20.8	6,710,000	19.2	6,745,000	9.2	6,655,000	4.3	6,660,000	12.9
Natural gasoline and related products	563,610	17.1	560,000	19.9	565,000	13.2	580,000	6.8	567,200	13.9
Crude-oil production, (domestic)	5,964,170	21.2	6,150,000	19.1	6,180,000	8.9	6,075,000	4.1	6,092,800	12.8
Crude oil run to stills	6,491,530	20.6	6,345,000	16.2	6,463,000	7.7	6,435,000	5.5	6,433,600	12.1
Crude oil transferred to products	22,880	9.6	22,000	8.4	23,000	13.8	25,000	6.8	23,700	10.0

*Exports of these products included in Miscellaneous Exports. †Includes refinery losses.

TABLE 3—DEMAND AND SUPPLY OF PETROLEUM PRODUCTS, 1951-52

	First quarter 1952		6 Months ending March 31, 1952	
Demands—	Forecast	Per cent increase over 1951	Forecast	Per cent change over prev. yr.
Motor fuel	2,905,000	6.2	2,995,000	7.8
Domestic	2,850,000	6.9	2,937,500	8.4
Exports	55,000	—13.8	57,500	—17.1
Kerosine	495,000	4.5	469,900	5.8
Domestic	490,000	4.5	464,900	4.1
Exports	5,000	0.0	5,000	—18.0
Distillate fuels	1,815,000	5.2	1,646,600	7.5
Domestic	1,785,000	5.4	1,614,100	7.8
Exports	30,000	— 1.5	32,500	— 3.5
Residual fuels	1,850,000	1.2	1,787,100	2.1
Domestic	1,820,000	1.8	1,754,600	2.7
Exports	30,000	—21.9	32,500	—20.9
Lubricants	151,000	— 4.0	151,500	— 2.3
Domestic	116,000	0.9	116,500	3.0
Exports	35,000	—17.1	35,000	—16.4
Wax	14,000	— 0.9	13,500	— 3.2
Domestic	11,000	9.5	10,500	4.7
Exports	3,000	—29.0	3,000	—23.3
Asphalts domestic*	110,000	6.3	134,800	4.2
Road oils domestic*	5,000	6.0	8,500	1.4
L.P.G. (incl. L.R.G.) domestic*	335,000	11.1	325,000	13.8
Misc. products & losses	320,000	5.2	320,000	5.6
Domestic†	300,000	4.2	300,000	4.9
Exports	20,000	22.1	20,000	17.6
Crude oil	120,000	24.8	120,000	— 1.4
Domestic—as such and losses	40,000	469.0	40,000	84.6
Exports	80,000	—10.2	80,000	—20.0
Total demand for all oils	8,120,000	5.0	7,971,700	5.9
Domestic	7,862,000	5.6	7,706,200	6.8
Exports	258,000	—10.8	265,500	—15.2
Supplies—				
Stock changes	—485,000		—356,800	
Crude oil	— 75,000		— 29,800	
Products	—410,000		—327,000	
Total new supply	7,635,000	2.4	7,614,900	3.2
Imports	990,000	6.9	964,900	4.5
Crude oil	530,000	9.6	525,000	6.4
Products	460,000	4.0	439,900	2.3
Domestic supply	6,645,000	1.8	6,650,000	3.1
Natural gasoline and related products	590,000	4.7	585,000	5.7
Crude-oil production	6,055,000	1.5	6,065,000	2.8
Crude-oil runs to stills	6,515,000	0.4	6,474,800	2.9
Crude oil transferred to products	25,000	9.3	25,000	9.1

*Exports included in miscellaneous exports. †Includes refinery losses.



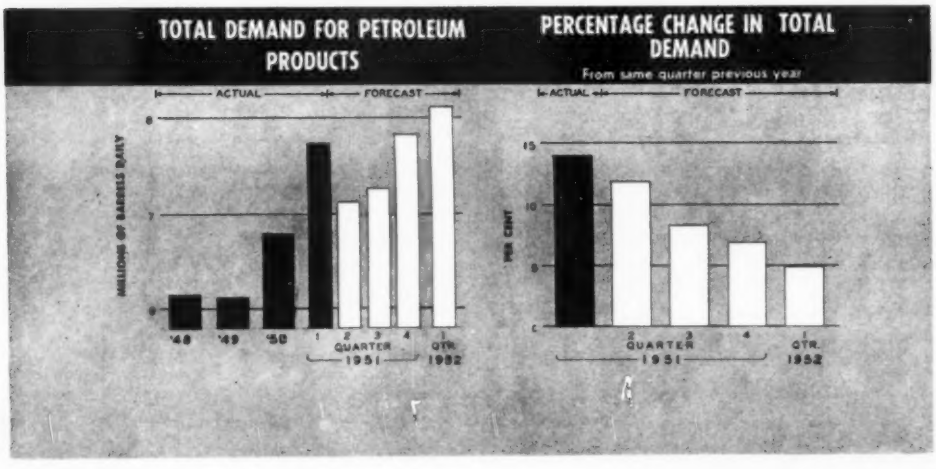
for 1951 have been forecast as shown in Table 2, and for the winter of 1951-52, as presented in Table 3.

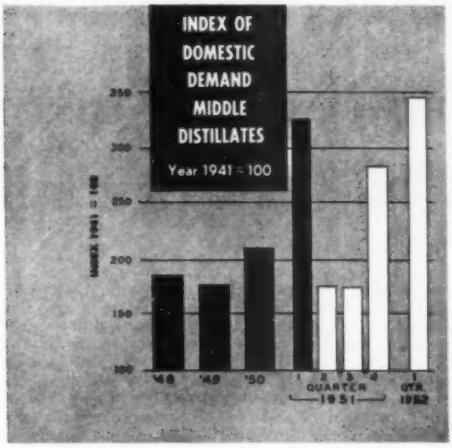
It is expected that in order to meet current demands and to build adequate product inventories, refinery operations will average about 6,463,000 bbl. daily during the third quarter of 1951, slightly less than the rate reported in the closing weeks of the second quarter, but 120,000 bbl. a day higher than the second-quarter average. Crude runs for these and subsequent periods are presented in Table 4 and are compared with refinery operations in previous years.

Refinery Yields of Major Products

Refinery yields of major products considered necessary to meet forecast demands, with refinery operations as projected, are outlined in Table 5.

Under those conditions stocks would follow patterns similar to those shown in Table 6. Such a program of refining operations provides a margin of safety to meet higher-than-forecast heating-oil de-





mands should weather conditions prove to be more severe than normal.

In the early months of 1951 United States stocks of crude oil fell to low levels relative to rates of demand for crude, but higher production rates, together with a somewhat lower demand in the second quarter, permitted these stocks to be returned to levels generally considered desirable for efficient operations. Crude-oil production is expected to continue at about June rates through the third quarter, with some further increase in stocks resulting. Forecast rates of crude-oil production are shown in more detail in Table 7.

The foregoing forecasts of demand and supply consider oil-industry operations in total and indicate that there will be sufficient supplies of raw material and adequate operating facilities. It should be recognized, however, that some operating districts would experience difficulties in meeting unusually high demands should the unexpected happen. For that reason, it is urgent that in those areas maximum use be made of available storage and transportation facilities during the third quarter of this year by early fillup of consumers' heating oil storage tanks.

TABLE 4—CRUDE-OIL RUNS TO STILLS IN THE UNITED STATES

	Barrels daily	Index	
1935-39 average	3,078,130	100.0	.....
1941	3,860,800	125.4	100.0
1948	5,595,560	181.8	144.9
1949	5,328,630	173.0	138.0
1950	5,739,360	186.5	148.7
1951:			
First quarter	6,491,530	210.9	168.1
Second quarter, est.	6,345,000	206.1	164.3
Third quarter	6,463,000	210.0	167.4
Fourth quarter	6,435,000	209.1	166.7
1952:			
First quarter	6,515,000	211.7	168.7

TABLE 5—YIELDS OF PRODUCTS—PER CENT OF CRUDE-OIL RUN

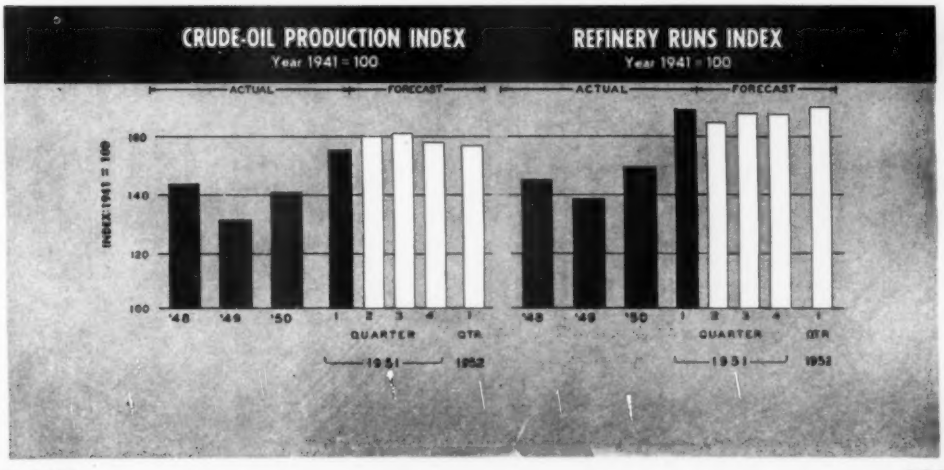
	Motor fuel	Kerosine	Distillate	Residual
1950:				
Fourth quarter	41.65	5.58	20.36	20.45
1951:				
First quarter	40.79	6.21	21.25	20.87
Second quarter (est.)	42.63	5.75	18.99	20.32
Third quarter	44.2	5.4	19.5	19.2
Fourth quarter	43.5	5.7	20.2	20.0
1952:				
First quarter	42.9	5.8	20.9	20.0

TABLE 6—STOCKS OF PETROLEUM PRODUCTS
(Thousands of barrels)

1951—	Finished Motor fuel	Kerosine	Distillate	Residual fuel
January 1	108,869	19,723	71,948	40,750
March 31	133,465	13,657	42,978	37,516
June 30 (est.)	118,000	23,700	66,300	42,600
September 30	105,300	31,300	97,500	50,000
December 31	110,200	24,400	82,300	47,000
1952—				
March 31	130,900	13,600	43,100	37,500

TABLE 7—UNITED STATES PRODUCTION OF CRUDE OIL

	Barrels daily	Index
Winter 1949-50	5,003,700	100.0
Summer 1950	5,421,200	108.3
Winter 1950-51	5,899,300	117.9
Summer 1951	6,165,100	123.2
Winter 1951-52	6,065,000	121.2



MIDYEAR REPORT

REFINING ACTIVITY

. . . Refinery runs exceed 6.4 million barrels daily during first half

NEW records were set by refiners in the first half of this year. Refinery runs averaged 6,443,000 bbl. daily for the 6-month period for an increase of 1,022,000 bbl. daily or 18.9 per cent over runs in the same months of 1950.

Runs were above 6,400,000 bbl. daily every month except April when the average dropped to 6,183,000 bbl. daily. Since the low point for 1950 also was in April, the increase for the corresponding month in 1951 was still almost 1,000,000 bbl. daily. The greatest increase over the same month of the previous year came in February when the monthly average of 6,562,000 bbl. daily represented a gain of 1,246,000 bbl. daily.

Part of the large increase for the first half of 1951 over the first half of 1950 has been due to the relatively low runs in the early part of 1950. Refinery operations for the first few months of that year were still influenced by the leveling-off trend of 1949. Crude runs for the first 6 months of 1950 were only 1.7 per cent greater than for the same months of 1949.

Total demand for all products in the first half of this year was about 13 per cent greater than in 1950. The wide margin between gains in demand and increases in runs for the two periods accounts for the difference in inventory trends. Product stocks increased about 15,000,000 bbl. in the January-June period of this year in contrast with stock reductions amounting to almost 33,000,000 bbl. in the first 6 months of 1950.

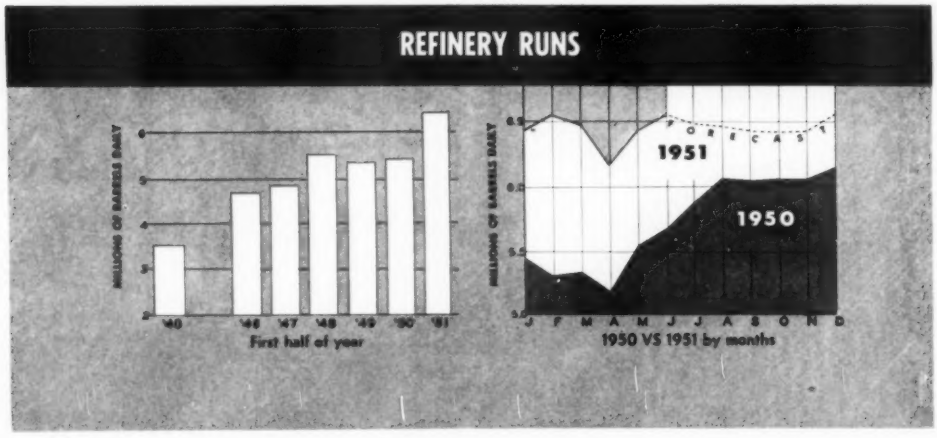
High runs and the resulting stock accumulation in the first 6 months of this year have eliminated the need for any large additional gains in refinery operations in the last half of the year. Demands in the last half, as now forecast, can be met by runs representing an increase of less than 1 per cent over the first half. This differs from the seasonal trend last year when last-half runs were up 11.6 per cent over the first half.

Texas Gulf Coast refining area accounted for almost 36 per cent of the total increase in runs for the first 6 months and had the highest percentage gain over the same period last year. Increases for combined Gulf Coast and East Coast areas amounted to 54.5 per cent of the total gain. Second largest district increase was reported for the Illinois-Indiana-Kentucky area, up 198,000 bbl. daily.

REFINERY RUNS BY DISTRICTS—JANUARY-JUNE
(Thousands of barrels daily)

	*1951	1950	Change	Per cent change
East Coast	1,014	862	+ 152	+17.6
Appalachian:				
District 1	102	92	+ 10	+10.9
District 2	77	70	+ 7	+10.0
Ill., Ind., Ky.	1,197	999	+ 198	+19.8
Okla., Kans., Mo.	526	459	+ 67	+14.6
Inland Texas	235	202	+ 33	+16.3
Texas Gulf Coast	1,555	1,191	+ 364	+30.8
La. Gulf Coast	489	448	+ 41	+ 9.2
N. La. and Ark.	79	69	+ 10	+14.5
Rocky Mountain:				
New Mexico	14	13	+ 1	+ 7.7
Other Rocky Mountain	213	173	+ 40	+23.1
California	942	843	+ 99	+11.7
Total United States	6,443	5,421	+1,022	+18.9

*Four months actual, 2 months estimated.


REFINERY RUNS
MILLIONS OF BARRELS DAILY
'46 '47 '48 '49 '50 '51
First half of year
FORECAST
1951
1950
J F M A M J J A S O N D
1950 VS 1951 by months

MIDYEAR REPORT

. . . Natural gasoline, cycling plants record greatest production gain in history

By JOHN C. CASPER

PRODUCTION at natural-gasoline and cycling plants averaged 551,600 bbl. daily for the first half of this year. This represents an increase of 78,100 bbl. daily over the average for the same months in 1950, an all-time record gain. Average production for the 6-month period was 2.4 times production in 1942, the first year for which complete light-hydrocarbon statistics were collected.

Natural-gasoline production averaged 229,600 bbl. daily for the first half, an increase of 24,200 bbl. daily or 11.8 per cent over production in the same period last year.

Production of L.P.G. increased to 236,600 bbl. daily compared with an average of 186,500 bbl. daily for the first half of 1950. For the first 4 months of the year, total production of L.P.G. exceeded natural-gasoline production by 3,000,000 bbl. This was more than enough to offset L.P.G. decreases in May and June, resulting in a 6-month average for L.P.G. that was larger than that for natural gasoline. L.P.G. output climbed above natural gasoline for a few mid-winter months of 1949-50 and 1950-51, but this is the first full half year for which the L.P.G. average was greater.

L.P.G. accounted for 64 per cent of the total increase in light-hydrocarbon production. This gain of 50,100 bbl. daily in L.P.G. production was more than total output of these products in 1942.

The trend for the past several years has been toward greater recovery of light products. In 1942 L.P.G. represented less than 22 per cent of total plant production. For the first half of 1951, these products accounted for almost 43 per cent of total output at natural-gasoline and cycle plants.

Despite recent increases in use of L.P.G. as fuel for internal-combustion engines, consumption remains highly seasonal with peak demands in the winter months. Since aboveground pressure storage is very expensive, off-season stock accumulation has been limited.

NATURAL-GASOLINE AND CYCLING PLANT PRODUCTION—JANUARY-JUNE
(Thousands of barrels daily)

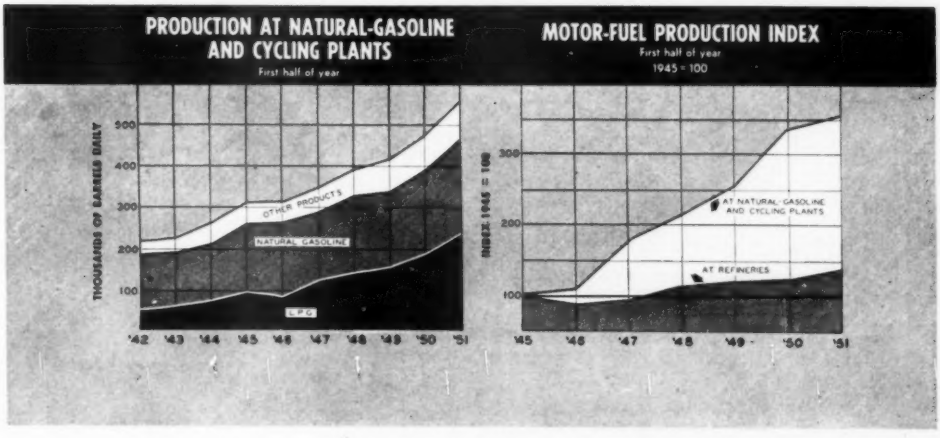
	*1951	1950	Change	Per cent change
Texas	290.6	241.5	+49.1	+20.3
California	80.4	74.2	+ 6.2	+ 8.6
Louisiana	60.5	53.7	+ 6.8	+12.7
Oklahoma	46.5	38.4	+ 8.1	+21.1
Other States	73.6	65.7	+ 7.9	+11.9
Total	551.6	473.5	+78.0	+16.5

*Four months actual, two months estimated.

PRODUCTION AT NATURAL-GASOLINE AND CYCLE PLANTS—FIRST HALF OF YEAR
(Thousands of barrels daily)

	Natural gasoline	L.P.G.	Other	Total	Per cent change
1942	133.6	48.7	43.1	225.4	
1943	133.7	58.0	41.7	233.4	+ 3.5
1944	139.0	72.3	50.9	262.2	+12.3
1945	159.6	98.5	54.0	312.1	+19.0
1946	174.5	87.7	49.3	311.5	— .2
1947	174.0	117.9	56.5	384.4	+11.8
1948	189.4	141.1	62.1	392.6	+12.7
1949	190.8	150.7	72.6	414.1	+ 5.5
1950	205.4	186.5	81.6	473.5	+14.3
1951*	229.6	236.6	85.4	551.6	+16.5

*Four months actual, two months estimated.



MIDYEAR REPORT

IMPORTS AND EXPORTS

. . . Exports rise due to turbulent conditions in Middle East, reversing former trend

By HENRY D. RALPH

BOTH imports and exports for the first half of this year were greater than in the first 6 months of 1950. Higher imports represent a continuation of a general upward trend that has existed since the end of the war. On the other hand, the gain for exports was the result of unsettled conditions in the Middle East and is counter to the trend of the past few years.

Total imports averaged 895,000 bbl. daily for the first half for an increase of 79,400 bbl. daily over last year. Over half of the increase was credited to residual fuel with all of the gain for this product in the first 2 months of the year. In fact, there was a decrease of about 1,500,000 bbl. in heavy-fuel imports for the March-June period compared with the same months of 1950.

Total exports averaged 335,000 bbl. daily, up 49,000 bbl. daily over last year. Increases were reported for every month except February, but over 35 per cent of the total gain came in May when export sales in this country were boosted by the partial shut down of the Abadan refinery because of the strike.

Crude exports were down only about 2,000 bbl. daily since full-scale shipments to Canadian refineries in the Sarnia area continued until the end of April when the first Alberta crude was received.

IMPORTS INTO CONTINENTAL UNITED STATES
(Thousands of barrels daily)

	Jan.-June* 1951	Jan.-June 1950	Change	Per cent change
Crude	507.3	470.2	+37.1	+ 7.9
Residual fuel	358.2	318.2	+40.0	+12.6
Other oils	30.0	27.7	+ 2.3	+ 8.3
Total imports	895.5	816.1	+79.4	+ 9.7

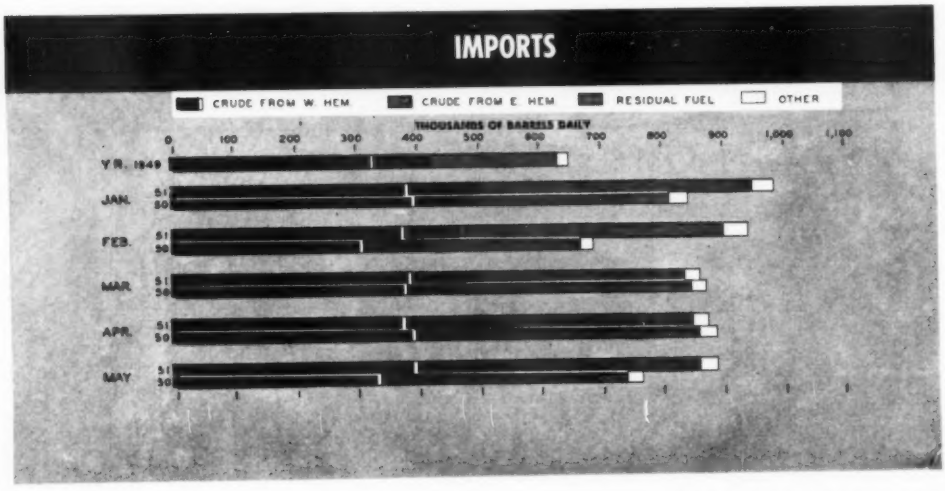
EXPORTS
(Thousands of barrels daily)

	Jan.-June* 1951	Jan.-June 1950	Change	Per cent change
Crude	84.7	86.3	— 1.6	— 1.9
Gasoline	74.7	64.5	+10.2	+15.8
Kerosine	9.4	4.9	+ 4.5	+91.8
Distillate fuel	43.4	33.3	+10.1	+30.3
Residual fuel	54.0	44.6	+ 9.4	+21.1
Lubes	44.4	36.6	+ 7.8	+21.3
Other products	24.4	15.8	+ 8.6	+54.4
Total exports	335.0	286.0	+49.0	+17.1

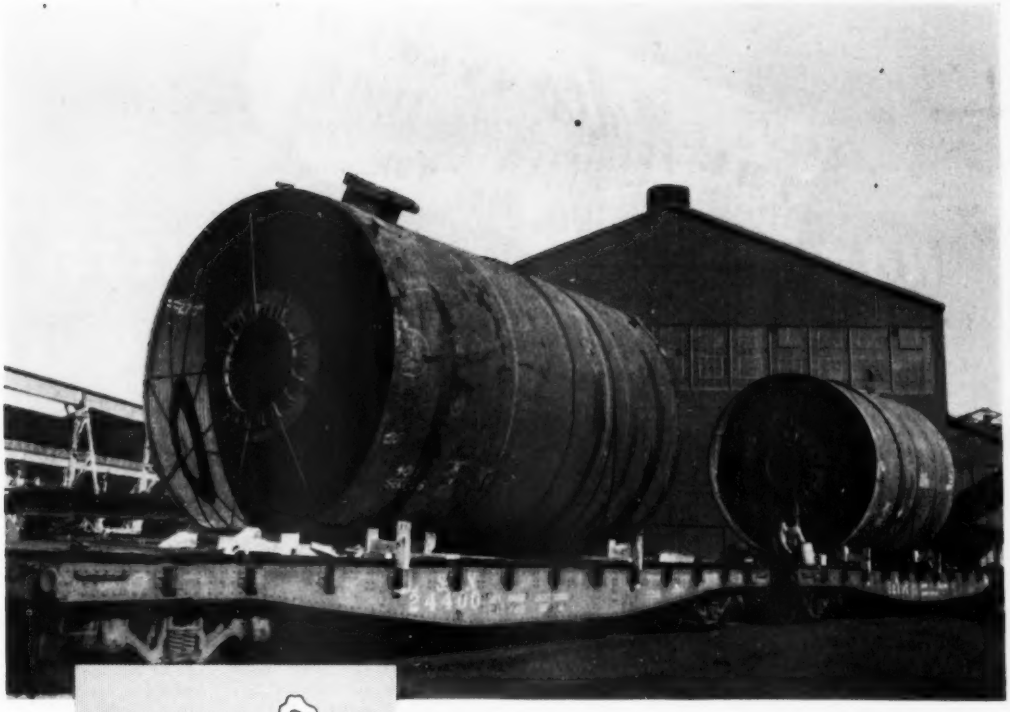
*Five months actual, one month estimated.

CRUDE IMPORTS BY COUNTRY OF ORIGIN
FIRST 5 MONTHS
(Thousands of barrels daily)

	Jan.-May 1951	Jan.-May 1950	Change	Per cent change
Colombia	46.0	46.8	— .8	— 1.7
Mexico	38.9	25.3	+13.6	+53.8
Venezuela	294.5	288.2	+ 6.3	+ 2.2
Iran		.7	— .7	
Kuwait	56.3	65.3	— 9.0	—13.8
Saudi Arabia	51.9	36.0	+15.9	+44.2
Qatar		.8	— .8	
British Borneo	8.3		+ 8.3	
Total crude	495.9	463.1	+32.8	+ 7.1



TO THE LAND OF PEARLS AND PETROLEUM



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Detroit, 26.....1514 Lafayette Bldg.
Houston, 2.....2119 National Standard Bldg.
Los Angeles, 17....1523 General Petroleum Bldg.
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MIDYEAR REPORT

PRODUCTION OUTSIDE UNITED STATES

. . . Production jumps another 20 per cent in countries outside United States

By DAHL M. DUFF

ANOTHER increase of approximately 20 per cent was shown in foreign crude-oil production, exclusive of the Russian areas, during the first half of this year.

Over-all non-Communist foreign output exceeded the rate of increase which was established during the year 1950. The gain of slightly more than 20 per cent during the first half of 1951 compares with a rise of about 18.5 per cent during 1950 as compared to 1949.

The possibility of evacuation of British personnel from Iran and the consequent deterioration of operations in this important oil country makes the outlook for the last half of this year highly uncertain. If this occurs, production will be raised to the utmost possible elsewhere, but the chances of replacing the immediate loss of 700,000 bbl. daily in less than a year or more are not good.

The 20.4 per cent increase in foreign oil production outside the Communist areas the first half of this year compares to an increase of 14.3 per cent in the first half of 1950 over the same period of 1949, and of 15.8 per cent in the first half of 1949 over the same period of 1948.

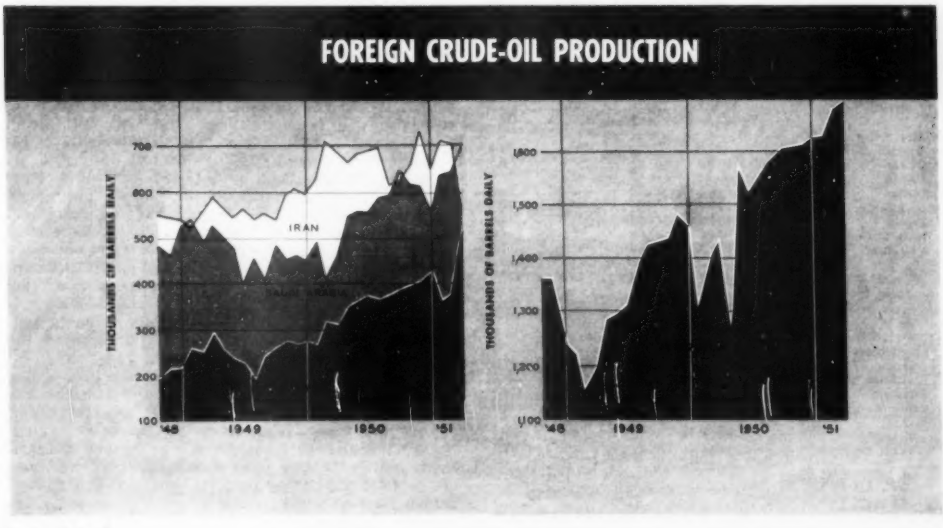
Countries making outstanding gains in crude production during the first half of the year included Canada, Colombia, Saudi Arabia, Kuwait, and British Borneo. Foreign production in the Western Hemisphere as a whole was up 18 per cent, most of it due to the slightly larger increase shown by Venezuela.

Because of the April decline, Iranian production during the first half of the year was little changed from the first 6 months of 1950, and as a result, the total increase in the Middle East was 23.3 per cent. This is a marked rise, but it is still somewhat below some of the increases in production in this region in the past few years.

Canada Shows Large Gain

Sharpest increase shown by any of the larger producing countries in the Western Hemisphere was the nearly 60 per cent rise in production in Canada. The most spectacular gains occurred in Canada in May and June and were the direct result of the commencement of tanker shipments on the Great Lakes which in turn allowed full use of the new Edmonton-Superior line of Interprovincial Pipe Line Co.

Preliminary figures place Canadian crude production in April at 141,600 bbl. daily and at 156,500 bbl. daily in May. Prior to the Leduc discovery in February 1947 and the following oil boom in the prairie provinces, total Canadian production was little more than 20,000 bbl. daily, and expected to decline due to depletion of the old fields. The movement of crude out of Alberta through the new pipe line and



its shipment to Ontario refineries marks the emergence of Canada as a major oil-producing country.

Venezuela, which still holds a long lead as the world's largest oil exporting country, showed consistent though smaller increases in production during the first half of the year. Venezuelan output has risen steadily since the latter part of 1950. The country is now producing at close to maximum levels but efforts to enlarge its output are certain to follow any shutdown in Iran. Venezuela still is a major supplier of oil to Europe, and would be called on to make up part of the deficit from Iran.

Production in Colombia averaged approximately 107,000 bbl. daily during the first 6 months of this year. This was an increase of 22 per cent over the same period of 1950 and was due almost entirely to the completion of additional pumping capacity in mid-1950 on the Andian National pipe line. This allowed increased movement to Caribbean export. No further large increases are anticipated in Colombia pending the discovery of new fields and construction of outlets for the oil.

Western Germany continues to show encouraging gains in production with the further development of discoveries made a year or two ago. The Italian state organization is conducting exploration, particularly in the Po Valley, but thus far the discoveries have been gas and gas liquids rather than crude oil.

The first half of 1951 saw crude production in the Middle East rise above the 2,000,000-bbl. daily mark for the first time. This was in April when total output of the seven producing countries in the region reached 2,011,000 bbl. daily, exceeding the previous record of 1,989,000 bbl. daily last December.

The increase of 23.3 per cent in Middle East production the first half of this year was accounted for principally in Saudi Arabia and Kuwait. As a result of the decline in Iran because of the Abadan strike in April, Saudi Arabia moved up to become the leading producer in the Middle East.

Saudi Arabian production rose steadily during the early part of this year and then received additional impetus because of the necessity of making up as far as possible the loss of Iran's output. Crude production in Saudi Arabia by mid-June was well above 750,000 bbl. daily. Unless some settlement is reached in Iran, this country undoubtedly will continue as the largest producer in the Persian Gulf. Its present position is in sharp contrast to that of a year and a half ago when markets for the dollar-produced oil were threatened by the dollar shortage and foreign currency restrictions.

Kuwait, where Anglo-Iranian holds a 50 per cent interest, showed a 42.3 per cent increase in production the first half of this year. In April, Kuwait production rose to 502,800 bbl. daily, dropping back slightly to 491,400 bbl. daily in May.

Kuwait's production probably could be enlarged 50 per cent or more in the next year. This amount of additional oil would be enough to satisfy excess refining capacity now available in the Eastern Hemisphere.

Increased throughput of the lines to Tripoli allowed an increase in production from Kirkuk field in Iraq. The approximately 170,000 bbl. daily now being produced is about the maximum possible until the completion of the new 30-32-in. line being laid to Banias on the Eastern Mediterranean. This will allow a several-fold expansion in Iraq production. Production also will be commenced next year by Basrah Petroleum Co., Ltd., on a commercial basis at initially probably about 40,000-50,000 bbl. daily.

Bahrein's output continues to remain around 30,000 bbl. daily, and efforts to develop deeper production have thus far been negative. Turkey's single field is largely shut in, but the government organization is now reported planning to erect a 4,000-bbl.-daily refinery which will allow utilization of the Ramandag crude. Qatar, where the production is controlled by an Iraq Petroleum Co. associate, now has an output of about 50,000 bbl. daily which probably will be stepped up as much as possible because of the shutdown in Iran.

Shell's British Borneo operation has in the last few years become a major source of oil in the Far East. Production is now believed to be in excess of 105,000 bbl. daily. Production in Indonesia is now back at the prewar level. It will be further enlarged next year with the Caltex organization beginning commercial production from its central Sumatra concession.

Foreign Crude-Oil Production

(Daily average in thousands of barrels)

Country—	First 6 mo. 1951*	First 6 mo. 1950	Percentage change	First 6 mo., 1949
Western Hemisphere:				
Argentina	68.3	64.0	6.7	61.9
Bolivia	1.3	1.7	—23.5	1.5
Brazil	1.8	0.6	200.0	0.3
Canada	108.0	67.9	59.1	52.9
Chile	1.7	1.9	—10.5	
Colombia	107.0	87.6	22.1	81.5
Cuba	0.3	0.4	—25.0	0.2
Ecuador	7.3	7.3		7.2
Mexico	204.0	190.1	7.3	159.6
Peru	42.6	40.3	5.7	40.3
Trinidad	56.7	56.4	0.5	56.3
Venezuela	1,672.0	1,406.3	18.9	1,236.2
Total	2,271.0	1,924.5	18.0	1,697.9
Europe and N. Africa:				
France	4.9	1.7	188.2	1.1
French Morocco	1.2	0.8	50.0	0.4
Germany	24.2	20.6	17.5	14.2
Italy	0.1	0.2	—50.0	0.2
Netherlands	14.1	13.8	2.2	11.6
Egypt	43.9	44.5	—1.3	42.5
United Kingdom	0.9	1.0	—10.0	0.9
Total	89.3	82.6	8.1	70.9
Middle East:				
Bahrein	30.1	30.1		30.2
Iran	665.0	662.9	0.3	561.3
Iraq	170.0	120.2	41.4	60.7
Kuwait	442.0	310.5	42.4	248.0
Qatar	47.0	28.4	65.5	
Saudi Arabia	671.0	489.1	37.2	508.5
Turkey	0.6	0.6		0.8
Total	2,025.7	1,641.8	23.4	1,409.5
Other Asia:				
British Borneo	105.0	77.6	35.3	64.3
Burma	2.0	1.0	100.0	0.5
China	2.2	1.5	46.6	1.5
India	5.0	5.2	—3.8	5.3
Indonesia	150.0	127.4	17.7	110.2
Japan	6.0	5.3	13.2	3.5
New Guinea	4.8	4.8		4.6
Pakistan	3.7	2.6	42.3	1.5
Total	278.7	225.4	23.6	191.4
Total foreign less Russia and E. Europe	4,664.7	3,874.3	20.4	3,369.7
Estimated Russia and Eastern Europe:				
Austria	27.0	22.0	22.7	17.5
Romania	82.0	82.0		90.0
Russia	790.0	730.0	8.2	650.0
Other E. Europe	24.1	23.0	4.8	18.0
Total	923.1	857.0	7.7	775.5
Total foreign	5,587.8	4,731.3	18.1	4,145.2

*Partly estimated.

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MIDYEAR REPORT

NATURAL-GAS EXPANSION

. . . Natural gas continues expansion despite difficulties in obtaining materials

By DAHL M. DUFF

INCREASING difficulties in obtaining line pipe and other necessary materials thus far have failed to check the growth trend of the natural-gas industry.

Utility sales of natural gas the first 4 months of this year were approximately 18.2 per cent higher than in the corresponding period of 1950. This gain is in line with that shown during the year 1950 when sales were 18.8 per cent over 1949.

The increase in natural-gas sales in the first 4 months of this year is even more striking in view of the fact that it was registered in spite of warmer weather during the period. Degree-days reported in natural-gas territory during the 4 months were slightly below the total for the same period in 1950.

These and other figures bear out the fact that the natural-gas industry actually is continuing to expand marketwise at a rate roughly twice that of the petroleum industry itself. Thus, while demand for petroleum products this year is expected to be 9 to 10 per cent over 1950, natural-gas sales will show double this increase assuming another good year.

The tremendous expansion which has taken place in natural gas since the end of the war is sometimes not fully appreciated in the petroleum industry. The accompanying chart, from data of the American Gas Association, shows the upward trend of gas sales since 1946, made possible by the multi-billion-dollar postwar program of long-distance pipeline construction.

In January, utility sales of natural gas reached a new all-time high of 4,743 million therms. This represented an increase of 19.3 per cent over the corresponding month of 1950. Degree-days in natural-gas territory were only 9.7 per cent greater than in January 1950.

The American Gas Association at the beginning of this year placed all its reports on a therm, rather than a cubic foot, basis. The therm equals 100,000 B.t.u. and is a measure of heat content. At the rough equivalent of 100 cu. ft. per therm, the record sales of the utility gas industry in January approximated 15,300,000,000 cu. ft.

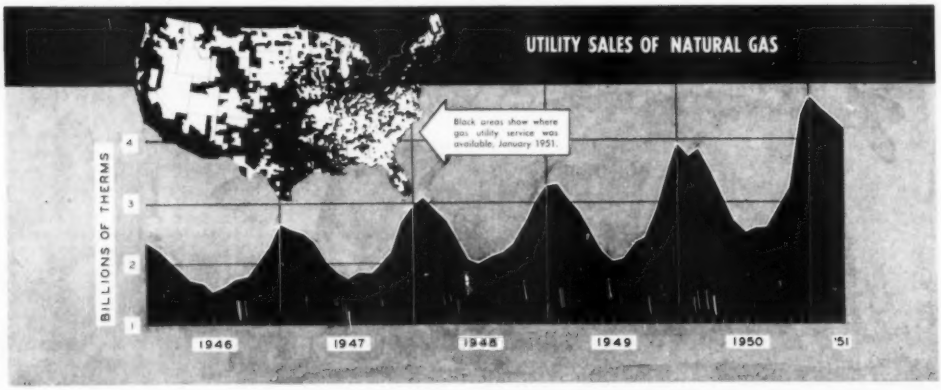
On the basis of an average well-head price of 6.5 cents, this meant an income to the producers of about $1,000,000 daily. As a further comparison, the sum obtained from the sale of gas during January was about the same as that which would be realized from 380,000 bbl. daily of $2.65 crude oil.

The natural-gas industry, with a greater portion of its sales for residential heating, is becoming an even more highly seasonal business. The chart showing the rising annual sales of natural gas also points up the marked spread between winter and summer sales. This characteristic of the gas industry is the source of perhaps its greatest operating problem, that of the peak load.

Growth in Underground Storage

From this standpoint, one of the outstanding operating developments in the gas industry is the fast-increasing use of underground storage as near as possible to points of consumption. It allows the transmission companies to take gas from the producers at a more even year-round rate and avoids the widely criticized practice of selling the gas during low-demand summer months as boiler fuel.

Another and highly significant recent trend in the natural-gas industry is the gradual entrance of the transmission companies into the field of gas exploration and production. This is a move toward gas-industry integration and is reflected in the in-



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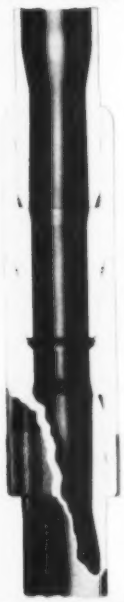

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GAS-UTILITY CONSTRUCTION EXPENDITURES, BY TYPE OF GAS AND BY PLANT FUNCTION, 1950-1955
(Millions of dollars)

Plant function—	Actual	Forecast					Total forecast	Total actual
	1950	1951	1952	1953	1954	1955	1951-1955	1946-1950
Natural gas—total	$1,095.7	$1,433.8	$1,205.8	$836.4	$494.1	$424.8	$4,194.9	$3,433.4
Production	76.7	89.1	95.1	58.0	38.0	34.6	314.8	
Underground storage	25.7	29.8	37.3	13.9	8.7	2.3	92.0	372.6
Other storage	9.3	10.8	9.1	9.5	13.5	3.8	46.7	
Transmission	713.3	994.8	773.0	295.4	185.8	146.8	2,395.8	2,187.8
Distribution	236.4	269.9	251.9	235.3	229.2	218.5	1,204.8	754.2
General	34.3	39.4	39.4	24.3	18.9	19.8	140.8	188.8

Source: Bureau of Statistics, American Gas Association.

creasing number of gas pipe-line companies that are launching producing subsidiaries.

Several factors contribute to this trend, but a principal one is that large blocs of undedicated gas reserves are becoming more and more difficult to find in the Southwest. Gas-industry executives have pointed out that various large oil companies are holding major gas reserves which they are unwilling to sell for one reason or another—fear of federal regulation, hope of a better price later, or a desire to use it in repressuring. Furthermore, a substantial part of the gas reserves is located in small fields uneconomic to reach by pipe line.

Regardless of the method by which the natural-gas industry acquires its gas, its pressing problem at present, as it has been since the end of the war, is to meet demands for service with existing facilities. In various sections of the Middle West particularly, gas installations are still restricted, and industrial customers subject to severe curtailment in order to supply peak winter load.

With last year's decision apportioning the New England market, the only important area in the country not now served by natural-gas pipe lines is the Pacific Northwest, and construction has been proposed to supply this area from either the Southwest or from Alberta. This leaves the industry with the problem of building up capacity and facilities into existing service areas. This type of work—looping, underground storage, additional compressor capacity, and other improvements—will continue into the indefinite future and involve capital outlays probably of the same magnitude as those connected with the boom of initial line construction the last 5 years.

Regulated Low Price

One powerful incentive behind the widening use of gas fuel is its regulated low price. In 1949, according to the latest available Bureau of Mines information, the average field price of natural gas in the United States was 6.3 cents per thousand cubic feet. Although the trend of gas prices in long-term contract has been upward, the 1949 average figure represented a reduction from the 6.5 cents in 1948 due to the decreased percentage of higher-priced Appalachian gas used in the systems.

In the Midwest, gas for house heating usually costs less than oil or coal. In Columbus, Ohio, for example, gas for many years was a premium fuel by comparison with bituminous coal. By 1945, however, the situation had changed so that the cost of heating a house in that city was about on a par with coal while the cost for oil was somewhat higher. Since 1945, natural-gas rates have been almost unchanged, but both oil and coal retail prices have risen sharply. As a result, in 1950, heating a six-room house in Columbus cost $207 with oil, $143 with bituminous coal, and only $89 with natural gas. Even in the East where transmission costs are much higher and the natural gas is mixed with high-cost manufactured gas, gas is frequently sharply competitive with oil. At present time, the Gas Appliance Manufacturers Association on one hand and the fuel-oil retailers on the other are engaged in rival selling campaigns in various sections of the East.

The recently completed survey of gas-industry construction expenditures by the statistical bureau of the American Gas Association gives evidence of the plans of the industry to continue large-scale expansion, even though long-distance lines now extend into virtually all areas of the country. The data are summarized in the accompanying table.

Of interest is the fact that the survey shows the industry expects to expend some $92,000,000 on underground storage in the next 5 years. The class of expense is listed for the first time. Previous surveys conducted by the bureau have shown that the estimates are generally conservative and particularly understated for the later years. Even on a survey of this nature companies hesitate to list projects not definite. Another factor at present is the uncertainty in securing pipe and other materials during the rearmament program.

Nature of Expansion

An especially interesting feature of this survey lies in a comparison with the result of that conducted by the association in the spring of 1950. It indicates that during the last 12 months there has been much additional planning and decisions for expansion within the companies. Total expenditures estimated for 1950-54 in last year's survey were $2,746,800,000 as compared with $4,194,900,000 estimated for 1951-55 in the recently completed study. For example, for 1951, last year's estimate showed $890,800,000. This year's survey lists 1951 expenditures at $1,433,800,000, with most of the difference going into transmission lines.

The Bureau of Mines has made a preliminary estimate of marketed production of natural gas in the United States in 1950 of 6,198,000,000,000 cu. ft. or 17,000,000,000 cu. ft. daily. The bureau's figures include not only the utility sales reported by the American Gas Association but also other sales such as to chemical plants and refineries. The 1950 estimate represents an increase of 14.4 per cent over the 1949 marketed total production of 5,419,736,000,000 cu. ft.

The bureau's latest detailed tabulation covers 1949, and in that year, interstate transmission of gas was up 14 per cent to 2,007,878,000,000 cu. ft., including 226,000,000 to Mexico and 19,828,000,000 to Canada. The figures indicate that about three-fourths of the final price of natural gas is due to transmission and distribution costs. Average value at point of consumption was 25.4 cents per thousand, with the wellhead value averaging 6.3 cents.

Texas supplied 48 per cent of the total marketed production, or 2,588,921,000,000 cu. ft. of the national total of 5,419,736,000,000 cu. ft. In addition to the marketed production, 798,211,000,000 cu. ft. was used during the year for repressuring, and 434,686,000,000 vented and wasted. Next behind Texas as a gas producer is Louisiana with a 1949 total of 732,845,000,000 cu. ft. marketed production. California, Oklahoma, and Kansas followed in that order.

MIDYEAR REPORT

REFINERY CONSTRUCTION ACTIVITY

. . . Current building projects will boost refinery output 500,000 bbl. daily

By R. B. TUTTLE

MIDYEAR of 1951 finds the refining division of the petroleum industry extremely active in modernizing and expanding its manufacturing facilities throughout the United States and Canada.

Major crude-oil-capacity increases are involved in 22 United States projects now under construction. This represents an increase of 500,000 bbl. of daily capacity. In addition, 15 other United States projects, either in the planning or authorized stage, involve 250,000 bbl. per day of crude-oil capacity.

The principal crude-oil-capacity increases involving Canadian refineries are in two projects totaling 74,500 bbl. daily. One of these projects is in the planning state while the other is under construction. With the addition of two new Canadian refineries which are now building, crude-oil capacity for that nation is scheduled at 4,000 bbl. of crude oil daily is now under construction. This new refinery capacity plus that of the expanded plants, boosts the nation's total by just short of 1,000,000 bbl. daily. Other projects not yet announced are expected to raise this figure to well above 1,000,000 bbl. daily before the year's end.

In the United States, four new refineries having a combined capacity rating of 135,000 bbl. of crude oil daily are in the planning stage. A fourth new refinery rated

Aside from 17 catalytic cracking units under construction in the United States, there are 20 projects in the planning stage at midyear. In addition to these projects, there are up for final approval 17 different installations for the manufacture of avgas blending materials and special aromatic products. Added to these are other facilities for upgrading gasoline.

Over all this year's midpoint finds United States and Canadian refiners pushing ahead at a rapid pace. Before the end of 1951 additional expansion and modernization programs, yet to be announced, are expected to increase United States refinery crude-oil capacity ratings to a total of around 7,500,000 bbl. daily for 1952.

Active Refinery-Building Projects

Company, location, and type of project—	Capacity rating	Status	Comp. schedule	Contractors
Aetna Oil & Refining Co., Louisville, Ky.:				
Plant expansion		Planned		
Aromatic Refinng Co., Baton Rouge, La.:				
Benzene unit, bbl. per day	640	Planned		
Av. gas blend stock unit, bbl. per day	1,360	Planned		
Reformer, bbl. per day	15,000	Planned		
Ashland Oil & Refining Co., Buffalo:				
Plant expansion		Planned		
Ashland Oil & Refining Co., Canton, Ohio:				
Expand cat. poly unit, bbl. per day	600	Planned		
Cat. cracking, bbl. per day	8,000	Planned		
Atlantic Refining Co., Philadelphia:				
Refinery expansion, bbl. per day	145,000	Planned		
Distillation unit, bbl. per day	50,000	Planned		
Fluid catalytic cracking unit		Planned		
Alkylation and polymerization equipment		Planned		
Atlas Processing Co., Shreveport, La.:				
Benzene unit, bbl. per day	420	Building		
Cat. reforming, bbl. per day	2,500	Building		
Aurora Gasoline Co., Detroit:				
Cat. reforming, bbl. per day	6,000	Planned		
Bay Petroleum Co., Shreveport, La.:				
Expand crude-oil capacity, bbl. per day	16,000	Building	1951	Universal Oil Products Co.; Procon, Inc.
Cat. cracker, bbl. per day	5,640	Building	1951	Universal Oil Products Co.; Procon, Inc.
Bell Oil & Gas Co., Granfield, Okla.:				
Platforming unit, bbl. per day	1,500	Building		Universal Oil Products Co.
Cracking furnace for three-coil cracking operation		Planned		
Ben Franklin Refining Co., Ardmore, Okla.:				
Expand crude-oil capacity, bbl. per day	4,500	Building		
Expand thermal cracker, bbl. per day	1,000	Building		
Ben Hur Refining Corp., Long Beach, Calif.:				
Cat. cracking, bbl. per day	6,000	Planned		
Thermal cracking, bbl. per day	3,000	Planned		
Cat. poly unit, bbl. per day	300	Planned		
British American Oil Co., Ltd., Moose Jaw, Sask., Canada:				
Refinery expansion, bbl. per day	10,000	Building	Late '51	Process Engineers, Inc.
Cat. cracker, cat. poly and coking units		Building	Late '51	Process Engineers, Inc.
Gas-concentration plant and storage facilities		Building	Late '51	Process Engineers, Inc.
Caminol Co., Hanford, Calif.:				
Expand crude-oil capacity, bbl. per day	1,000	Building		

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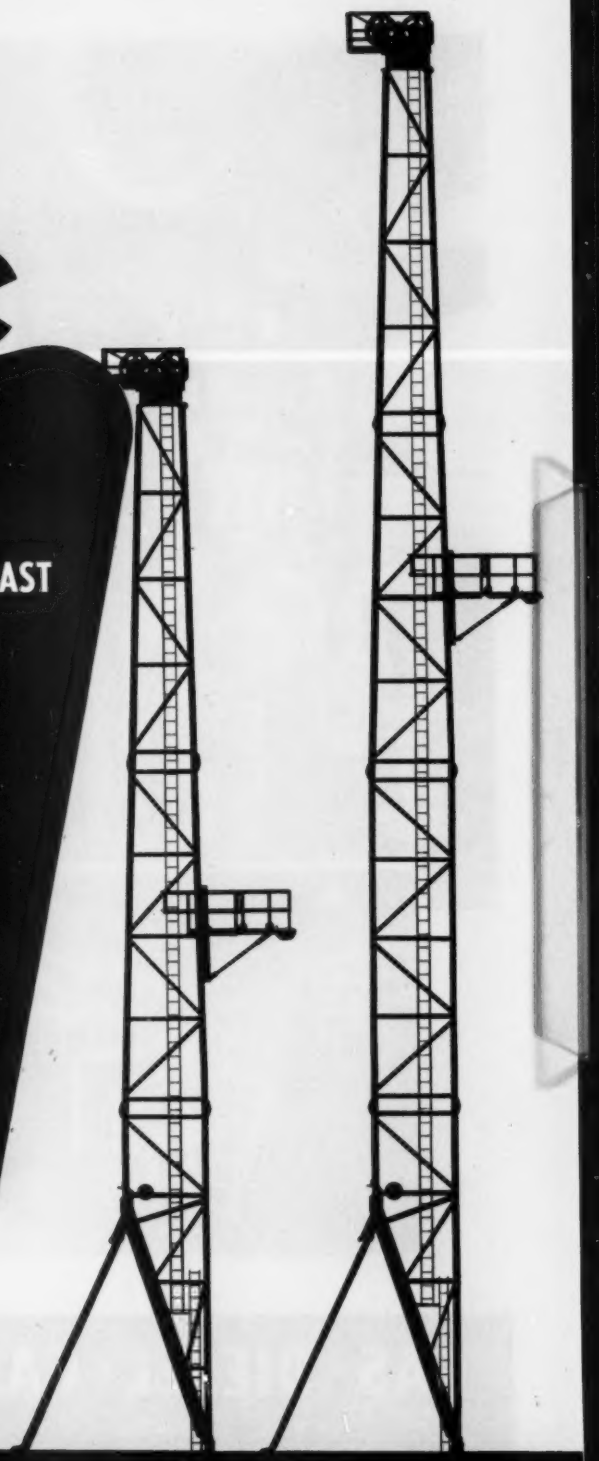

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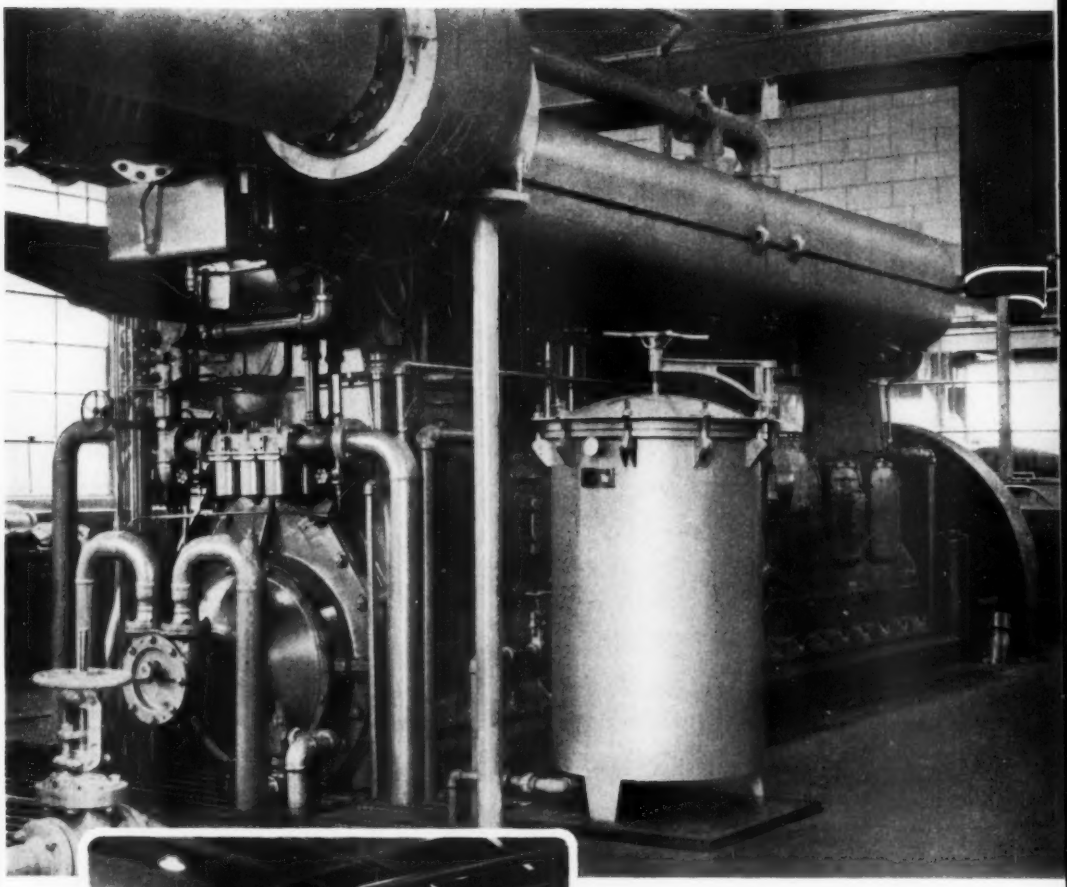

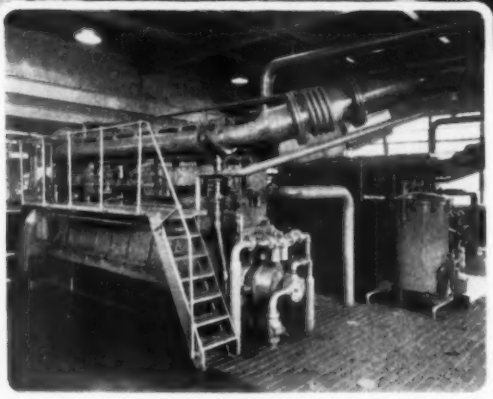

Cooper-Bessemer LS-8 supercharged gas-diesel, 1,715 hp, in Mid-Valley Clarkson station. Number of these units on line will soon total 15 . . . 3 in each of 5 different stations, including new stations at Pyrmont, Ohio, and Simpsonville, Kentucky and Minter City, Miss.

Cooper-Bessemer JS-8 gas-diesel (before supercharging) in Haynesville, La., station. This and 3 other original JS's are being converted, an increase from 800 to 1200 hp each. In addition 5 new supercharged JS's are being added, one each in Longview and Haynesville main stations, plus 3 in the new Stevenson booster station.

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New York Washington, D. C. Bradford, Pa. Parkersburg, W. Va.
San Francisco, Cal. Houston, Dallas, Greggton, Pampa and Odessa, Texas Seattle, Wash.

MORE POWER TO THE MID-VALLEY LINE

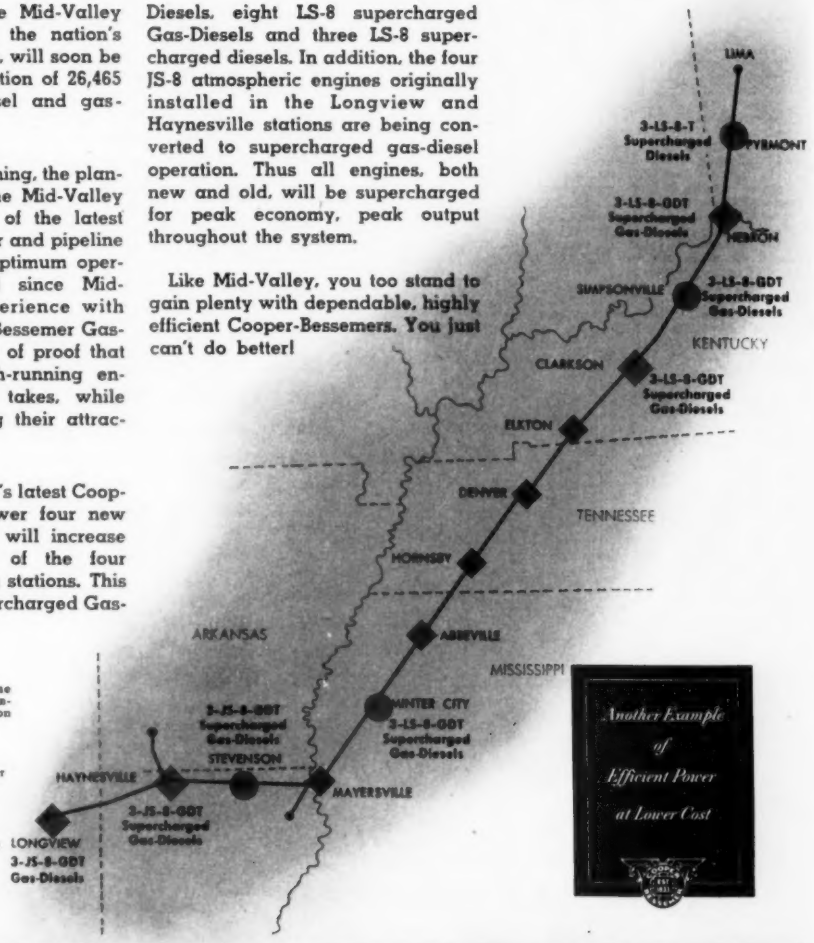
...with 16 additional Cooper-Bessemer supercharged diesels and gas-diesels

The capacity of the Mid-Valley Line, already one of the nation's largest oil line systems, will soon be expanded by the addition of 26,465 Cooper-Bessemer diesel and gas-diesel horsepower.

From the very beginning, the planning that went into the Mid-Valley Line took advantage of the latest developments in power and pipeline engineering to gain optimum operating economy. And since Mid-Valley has had experience with their original Cooper-Bessemer Gas-Diesels, there's plenty of proof that these modern, smooth-running engines have what it takes, while considerably bettering their attractive guarantees.

The Mid-Valley Line's latest Cooper-Bessemers will power four new booster stations, and will increase the power in each of the four original engine-driven stations. This calls for five JS-8 supercharged Gas-Diesels, eight LS-8 supercharged Gas-Diesels and three LS-8 supercharged diesels. In addition, the four JS-8 atmospheric engines originally installed in the Longview and Haynesville stations are being converted to supercharged gas-diesel operation. Thus all engines, both new and old, will be supercharged for peak economy, peak output throughout the system.

Like Mid-Valley, you too stand to gain plenty with dependable, highly efficient Cooper-Bessemers. You just can't do better!



Map of Mid-Valley Pipe Line Company's 1000-mile system including new stations and station expansions.

- Original Cooper-Bessemer powered stations
- New Cooper-Bessemer powered stations
- Electric powered stations (original and new)

Another Example of Efficient Power at Lower Cost

by **Cooper-Bessemer**

MOUNT VERNON, OHIO AND GROVE CITY, PENNA.

Tulsa Shreveport St. Louis Los Angeles Chicago Caracas, Venezuela

ACTIVE REFINERY-BUILDING PROJECTS (Continued)

Company, location, and type of project	Capacity rating	Status	Comp. schedule	Contractors
Canadian Oil Refineries, Ltd., Froomfield, Ont., Canada:				
New refinery:				
Atmospheric and vacuum dist. units, bbl. per day	20,000	Building	Early '52	E. B. Badger & Sons Co.
Cat. cracking, gas processing, and cat. poly units, bbl. per day	8,000-10,000	Building	Early '52	M. W. Kellogg Co.
Cat. reforming unit, bbl. per day	3,800	Building	Early '52	Universal Oil Products Co.
Storage, bbl.	1,600,000	Building	Early '52	Horton Steel Co.
Wharf and offsite facilities		Building	Early '52	
Visbreaking unit, bbl. per day	3,000	Building	Early '52	
Cat. poly unit, bbl. per day	800	Building	Early '52	
Cities Service Oil Co., Ponca City, Okla.:				
Cat. cracker, bbl. per day	10,000	Building	Early '52	M. W. Kellogg Co.
Expand crude-oil capacity, bbl. per day	11,000	Planned		
Cities Service Oil Co., Linden, N. J.:				
Vacuum unit			1951	
Rebuild entire dock			1951	
Col-Tex Refining Co., Colorado City, Tex.:				
Poly unit, bbl. per day	75	Building	.....	.....
Consumer Cooperative Refinery Assn., Levelland, Tex.:				
Cat. cracking, bbl. per day	3,000	Planned	.....	.....
Cat. poly, bbl. per day	150	Planned	.....	.....
Continental Oil Co., Lake Charles, La.:				
Modernize and enlarge refinery, bbl. per day	11,700	Building	Early '52	E. B. Badger & Sons
Cat. cracker (T.C.C.), bbl. per day	7,000	Building	Early '52	E. B. Badger & Sons
Polyforming unit, bbl. per day	2,500	Building		
Alkylation (sulfuric) unit, bbl. per day	835	Building		
Benzene facilities, bbl. per day	182	Planned	.....	.....
Toluene facilities, bbl. per day	636	Planned	.....	.....
Cosden Petroleum Corp., Big Spring, Tex.:				
Cat. reforming, bbl. per day	4,000	Planned	.....	.....
Benzene facilities, bbl. per day	100	Planned	.....	.....
Toluene facilities, bbl. per day	230	Planned	.....	.....
Aromatic base facilities, bbl. per day	420	Planned	.....	.....
Crown Central Petroleum Corp., Houston:				
Crude-oil expansion, bbl. per day	2,350	Planned	.....	.....
Deep Rock Oil Corp., Cushing, Okla.:				
Lubricating-oil expansion, bbl. per day	150	Building	.....	.....
Derby Oil Co., Wichita, Kans.:				
Increase crude capacity, bbl. per day	5,000			
Cat. cracker, bbl. per day	7,500	Building	1952	Fluor Corp., Ltd.
Poly unit		Building	1952	Universal Oil Products Co.; Fluor Corp., Ltd.
Gas recovery plant		Building	1952	Fluor Corp., Ltd.
Douglas Oil Co. of California, Paramount, Calif.:				
Thermal cracking expansion, bbl. per day	1,000	Building	.....	.....
Envoy Petroleum Co., Long Beach, Calif.:				
Oxidizing unit, bbl. per day	500	Building	.....	.....
Esso Standard Oil Co., Bayway, N. J.:				
Desalting units, total bbl. per day	100,000	Building	1951	Fluor Corp., Ltd.
Esso Standard Oil Co., Everett, Mass.:				
Cat. cracking unit, bbl. per day	18,500	Contracted	Early '53	Foster Wheeler Corp.
Rerun unit, bbl. per day	7,000	Planned	.....	.....
Esso Standard Oil Co., Baton Rouge, La.:				
Cat. cracking unit, bbl. per day	31,000	Planned	.....	.....
Crude distillation, bbl. per day	11,000	Planned	.....	.....
Excelsior Refineries, Ltd., Lloydminster, Alta, Canada:				
Vacuum unit, bbl. per day	1,500	Building	1951	Koch Engineering Co.
Famriss Oil & Refining Co., Hobbs, N. M.:				
Capacity increase, bbl. per day	600	Building	1951	Refinery Engineering Co.
Fletcher Oil Co., Wilmington, Calif.:				
Capacity increase, bbl. per day	5,000	Building	Early '52	Fletcher Oil Co.
Thermal cracking expansion, bbl. per day	1,400	Building		
Poly unit expansion, bbl. per day	25	Building	.....	.....
Fulton & Olmstead, San Antonio:				
New refinery:				
Atmospheric crude-distillation unit, bbl. per day	10,000	Planned	.....	.....
Fluid catalytic cracking unit, bbl. per day	5,000	Planned	.....	.....
HF alkylation unit, bbl. per day	2,500	Planned	.....	.....
Av. alkylate facilities, bbl. per day	1,335	Planned	.....	.....
Gilmore refineries, Inc., Odessa, Tex.:				
New refinery, bbl. per day	50,000	Planned	.....	.....
Great Northern Oil Co., St. Paul:				
Crude unit, bbl. per day	30,000	Planned	.....	.....
Cat. cracker, bbl. per day	7,500	Planned	.....	.....
Alkylation, bbl. per day	2,500	Planned	.....	.....
Cat. reforming, bbl. per day	6,000	Planned	.....	.....
Cat. poly, bbl. per day	700	Planned	.....	.....
Gulf Oil Corp., Philadelphia:				
Refinery expansion:				
Cat. cracker, bbl. per day	47,000	Planned		
Vacuum topping unit, bbl. per day	76,000	Planned		
Reforming unit, bbl. per day	9,000	Planned		
Gulf Oil Corp., Port Arthur, Tex.:				
Cat. cracker, bbl. per day	60,000	Building		M. W. Kellogg Co.
Ethylene plant, cu. ft. per year	2,500,000,000	Planned	Early '52	
Isooctyl-alcohol plant, lb. per year	9,000,000	Planned	Early '52	
Humble Oil & Refining Co., Baytown, Tex.:				
Crude-oil expansion, bbl. per day	70,000	Building	.....	.....
Cat. cracking expansion, bbl. per day	7,400	Building	.....	.....
Husky Oil & Refining, Ltd., Lloydminster, Alta., Canada:				
Desalting unit		Building	Mid '51	Husky Oil & Refining Co.
Enlarge boiler plant		Building	Mid '51	Husky Oil & Refining Co.
Additional tankage		Building	Mid '51	Husky Oil & Refining Co.

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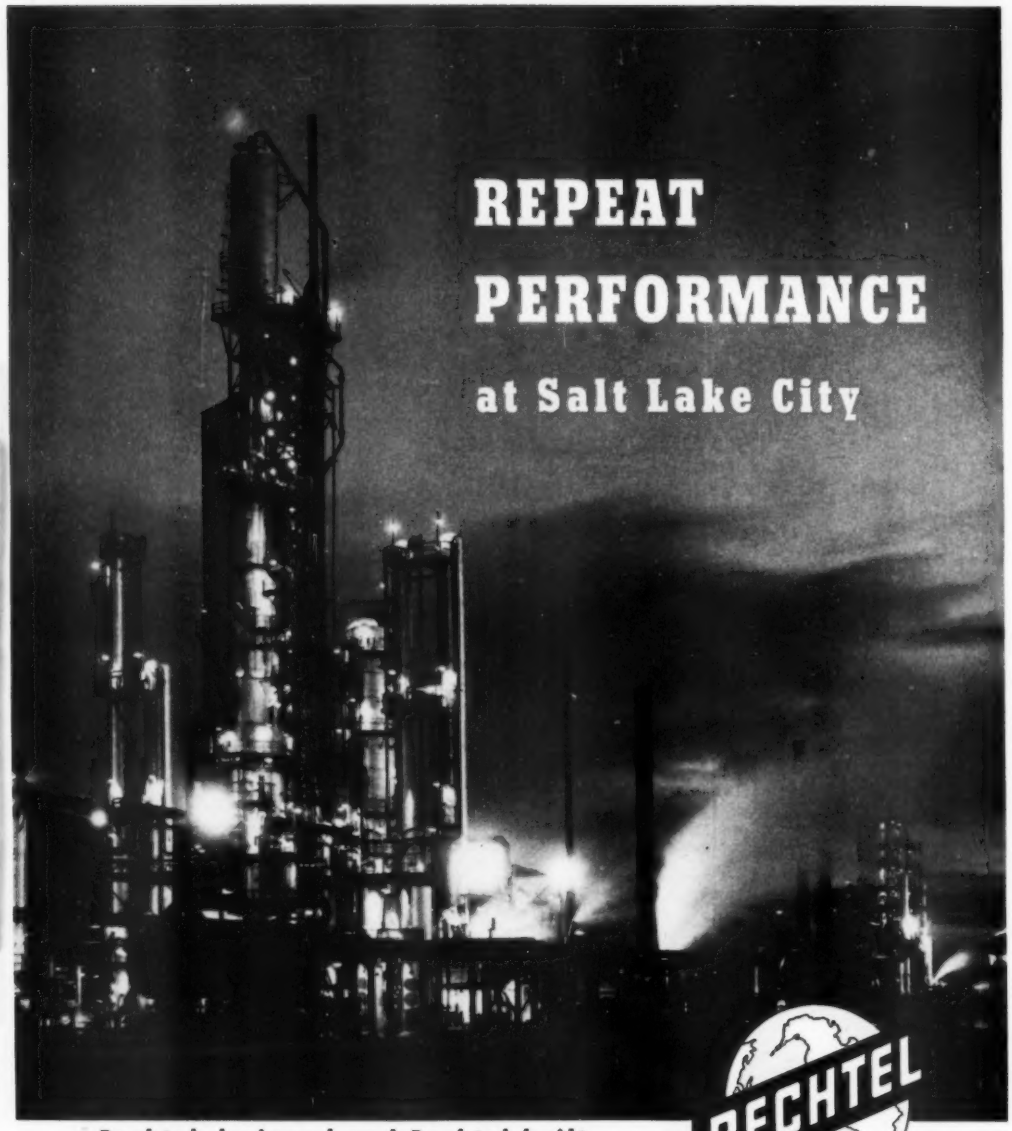

Bechtel designed and Bechtel built—

The expansion program recently completed for Salt Lake Refining Company, a subsidiary of Standard Oil Company of California, meets the needs of a growing market and the greater demand for high octane fuels. It was another "encore" for Bechtel Corporation at a refinery we originally engineered and constructed.

BECHTEL CORPORATION

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"BUILDERS FOR INDUSTRY"

PROCESS DESIGN • ENGINEERING • PURCHASING • CONSTRUCTION

ACTIVE REFINERY-BUILDING PROJECTS (Continued)

Company, location, and type of project—	Capacity rating	Status	Comp. schedule	Contractors
Imperial Oil, Ltd., Edmonton, Alta., Canada:				
Cat. cracking unit, bbl. per day	10,000	Planned	Early '52	Foster Wheeler Co., Ltd.
Vacuum unit, bbl. per day	10,000	Planned	.....	.....
Imperial Oil, Ltd., Sarnia, Ont., Canada:				
Plant expansion, bbl. per day	71,000	Planned	Late '52	Canadian Kellogg Co., Ltd.
Atmospheric and vacuum distillation unit	46,500	Planned	Late '52	Canadian Kellogg Co., Ltd.
Cat. cracking unit	23,250	Planned	Late '52	Canadian Kellogg Co., Ltd.
Johnson Oil Refining Co., Cleveland, Okla.:				
Platforming	1,840	Building	1951	Procon, Inc.; Universal Oil Products Co.
Kanotex Refining Co., Arkansas City, Kans.:				
Crude-oil expansion, bbl. per day	5,000	Planned	.....	.....
Cat. cracking, bbl. per day	4,500	Planned	.....	.....
Kendall Refining Co., Bradford, Pa.:				
Platforming unit, bbl. per day	1,500	Building	1951	Procon, Inc.; Universal Oil Products Co.
Lion Oil Co., El Dorado, Kans.:				
Av. alkylate facilities, bbl. per day	432	Planned	.....	.....
Louisville Refining Co., Louisville, Ky.:				
Cat. cracking, bbl. per day	3,000	Building	Mid '51	Universal Oil Products Co.; Petroleum Piping Co.
McColl-Frontenac Oil Co., Ltd., Edmonton, Alta., Canada:				
New refinery:				
Cat. cracker, bbl. per day	2,600	Building	Mid '51	Foster Wheeler; Burns & Dutton
Distillation unit, bbl. per day	5,500	Building	Mid '51	Foster Wheeler; Burns & Dutton
Delayed coker, bbl. per day	2,200	Building	Mid '51	Foster Wheeler; Burns & Dutton
Poly unit, bbl. per day	250	Building	Mid '51	Foster Wheeler; Burns & Dutton
McColl-Frontenac Oil Co., Ltd., Montreal, Que., Canada:				
Poly unit expansion, bbl. per day	500	Building	.....	.....
McNutt Oil & Refining Co., Inc., Brickland, N. M.:				
Poly unit, bbl. per day	50	Building	.....	.....
Mercury Oil Refining Co., Oklahoma City:				
Cat. cracking, bbl. per day	2,500	Planned	.....	.....
Cat. poly unit, bbl. per day	360	Planned	.....	.....
M.F.A. Oil Co. (Delta Refining Co.), Memphis:				
Crude-oil expansion, bbl. per day	2,000	Planned	.....	.....
Cat. cracking, bbl. per day	2,200	Planned	.....	.....
Cat. poly unit, bbl. per day	100	Planned	.....	.....
Mid-West Refineries, Inc., Alma, Mich.:				
Platforming unit, bbl. per day	1,750	Building	Mid '51	Universal Oil Products Co.; Procon, Inc.
National Cooperative Refinery Assn., McPherson, Kans.:				
Cat. cracker, bbl. per day	10,000	Building	.....	Refinery Engineering Co.
Cat. poly unit, bbl. per day	600	Building	.....	Refinery Engineering Co.
Increase crude unit, bbl. per day	3,000	Building	.....	Refinery Engineering Co.
Revamp vacuum unit, bbl. per day	10,650	Building	.....	Refinery Engineering Co.
Revamp thermal cracker, bbl. per day	2,940	Building	.....	Refinery Engineering Co.
New Mexico Asphalt & Refining Co., Artesia, N. M.:				
Cat. cracker, bbl. per day	6,000	Building	1951	Southwestern Engineering Co.
Cat. poly unit, bbl. per day	300	Building	1951	Southwestern Engineering Co.
Northwestern Refining Co., St. Paul Park, Minn.:				
Crude-oil expansion, bbl. per day	1,000	Planned	.....	.....
Cat. cracking, bbl. per day	2,700	Planned	.....	.....
Old Dutch Refining Co., Muskegon, Mich.:				
Crude-oil expansion, bbl. per day	3,700	Planned	.....	.....
Cat. reforming, bbl. per day	500	Planned	.....	.....
Benzene facilities, bbl. per day	150	Planned	.....	.....
Toluene facilities, bbl. per day	370	Planned	.....	.....
Onyx Refining Co., Abilene, Tex.:				
Revamp topping unit, bbl. per day	5,500	Building	Late '51	Onyx Refining Co.
Revamp stabilizer		Building	Late '51	
Platforming unit, bbl. per day	900	Building	Late '51	Universal Oil Products Co.; Procon, Inc.
Crude-oil expansion, bbl. per day	1,000	Building	.....	.....
Poly unit, bbl. per day	100	Building	.....	.....
Oriental Refining Co., Denver:				
Cycloversion unit, bbl. per day	1,500	Building	.....	.....
Pacific Refineries, Ltd., Hawaii:				
New refinery, bbl. per day	3,000	Building	1951	Fish Engineering Co.
Pan-Am Southern Corp., Destrehan, La.:				
Crude-oil expansion, bbl. per day	22,000	Planned	Mid '52	
Catalytic cracking unit, bbl. per day	12,000	Planned	Mid '52	
Av. alkylate facilities, bbl. per day	2,500	Planned	.....	.....
Pan American Refining Co., Texas City, Tex.:				
Toluene facilities, bbl. per day	600	Planned	.....	.....
Panhandle Production & Refining Co., Wichita Falls, Tex.:				
Increase crude-oil capacity, bbl. per day	8,000	Planned	.....	.....
Petroleum Specialties, Inc., Flat Rock, Mich.:				
Platforming unit, bbl. per day	900-1,000	Building	.....	.....
Phillips Oil Co., Phillips, Tex.:				
Cat. cracker, bbl. per day	30,000	Building	Mid '51	C. F. Braun Co.
Phillips Oil Co., Sweeny, Tex.:				
Crude-oil expansion, bbl. per day	13,000	Planned	.....	.....
Expand cat. cracking, bbl. per day	2,000	Planned	.....	.....
Av. alkylate facilities, bbl. per day	1,800	Planned	.....	.....
Phillips Petroleum Co., Borger, Tex.:				
Crude-oil expansion, bbl. per day	8,000	Planned	.....	.....
Av. alkylate facilities, bbl. per day	1,400	Planned	.....	.....
Phillips Petroleum Co., Okmulgee, Okla.:				
Cat. cracking unit, bbl. per day	...	Building	Mid '52	Fluor Corp., Ltd.
Phillips Petroleum Co., Woods Cross, Utah:				
Cat. cracking unit, bbl. per day	10,000	Building	Mid '52	Fluor Corp., Ltd.

ACTIVE REFINERY-BUILDING PROJECTS (Continued)

Company, location, and type of project—	Capacity rating	Status	Comp. schedule	Contractors
Premier Petroleum Co., Fort Worth:				
Crude-oil expansion, bbl. per day	6,000	Planned	.....	.....
Cat. cracking, bbl. per day	4,300	Planned	.....	.....
Cat. poly, bbl. per day	380	Planned	.....	.....
Platforming unit, bbl. per day	1,500	Building	Mid '51	Universal Oil Products Co.; Premier Petroleum Co.
Puerto Rican Refining Co., Puerto Rico:				
Crude-oil capacity, bbl. per day	20,000	Planned	.....	.....
Cat. cracking, bbl. per day	11,000	Planned	.....	.....
Av. alkylate facilities, bbl. per day	500	Planned	.....	.....
Pure Oil Co., Smiths Bluff, Tex.:				
Crude-oil expansion, bbl. per day	12,100	Planned	.....	.....
Expand cat. cracking, bbl. per day	17,000	Planned	.....	.....
Cat. poly, bbl. per day	135	Planned	.....	.....
Av. alkylate facilities, bbl. per day	1,900	Planned	.....	.....
Pure Oil Co., Toledo:				
Cat. cracking, bbl. per day	10,500	Planned	.....	.....
Cat. poly, bbl. per day	600	Planned	.....	.....
R. J. Oil & Refining Co., Inc., Princeton, Ind.:				
Crude-oil expansion, bbl. per day	4,000	Building	.....	.....
Cat. cracker, bbl. per day	1,500	Planned	.....	.....
Roosevelt Oil & Refining Co., Mount Pleasant, Mich.:				
Benzene facilities, bbl. per day	210	Planned	.....	.....
Toluene facilities, bbl. per day	225	Planned	.....	.....
Rothschild Oil Co., Santa Fe Springs, Calif.:				
Cat. cracking, bbl. per day	6,000	Planned	.....	.....
Salt Lake Refining Co., Salt Lake City:				
Vacuum unit, bbl. per day	9,500	Building	.....	Bechtel Corp.
Saskatchewan Federated Co-operative, Ltd., Regina, Sask.:				
Crude-oil expansion, bbl. per day	3,500	Building	1951	.....
Thermal cracking expansion, bbl. per day	1,500	Building	1951	.....
Shell Oil Co., Houston, Tex.:				
Platforming unit, bbl. per day	15,000	Building	1951	Universal Oil Products Co.; Procon, Inc.
Benzene facilities, bbl. per day	1,250	Planned	.....	.....
Aromatic base facilities, bbl. per day	3,750	Building	.....	Foster Wheeler Corp.
Shell Oil Co., Wood River, Ill.:				
Platforming unit, bbl. per day	15,000	Building	1951	Universal Oil Products Co.; Procon, Inc.
Av. alkylate facilities, bbl. per day	164	Planned	.....	.....
Toluene facilities, bbl. per day	225	Planned	.....	.....
Sinclair Refining Co., Houston:				
Crude-oil expansion, bbl. per day	25,000	Planned	.....	.....
Cat. cracking, bbl. per day	40,000	Planned	.....	.....
Sinclair Refining Co., East Chicago, Ind.:				
Vacuum unit, bbl. per day	20,000	Contracted	.....	Arthur G. McKee Co.
Socony-Vacuum Oil Co., Inc., Brooklyn:				
Convert cat. cracker, bbl. per day	12,000	Building	Mid '51	Foster Wheeler Corp.
Cat. poly unit, bbl. per day	900	Building	Mid '51	Foster Wheeler Corp.
Socony-Vacuum Oil Co., Inc., East Chicago, Ind.:				
Convert cat. cracker, bbl. per day	15,000	Building	Late '51	C. F. Braun Co.
Socony-Vacuum Oil Co., Inc., Paulsboro, N. J.:				
Naphtha reformer, bbl. per day	12,000	Building	Mid '51	C. F. Braun Co.
T.C.C. unit, bbl. per day	15,000	Building	Late '52	Fluor Corp., Ltd.
Southwestern Oil & Refining Co., Corpus Christi, Tex.:				
Crude-oil expansion, bbl. per day	15,300	Planned	.....	.....
Cat. cracking, bbl. per day	5,000	Planned	.....	.....
Standard Oil Co. (Calif.), El Segundo, Calif.:				
Benzene facilities, bbl. per day	850	Building	Mid '52	Fluor Corp., Ltd.
Toluene facilities, bbl. per day	3,200	Building	Mid '52	Fluor Corp., Ltd.
Platforming unit, bbl. per day	10,000	Building	.....	.....
Standard Oil Co. (Calif.), Richmond, Calif.:				
Vacuum unit, bbl. per day	50,000	Building	Late '51	M. W. Kellogg Co.
Isobutane facilities	.....	Planned	.....	.....
Standard Oil Co. (Ind.), Neodesha, Kans.:				
Increase plant capacity, bbl. per day	9,300	Building	.....	.....
Add cracking facilities, bbl. per day	5,000	Planned	.....	.....
Av. alkylate facilities, bbl. per day	850	Planned	.....	.....
Standard Oil Co. (Ind.), Sugar Creek, Mo.:				
Refinery expansion, bbl. per day	68,000	Building	Late' 52	.....
Combination crude-running and coking unit	.....	Building	.....	.....
Standard Oil Co. (Ind.), Wood River, Ill.:				
Alcohol unit, lb. per year	10,000,000	Authorized	.....	.....
Standard Oil Co. (Ind.), Whiting, Ind.:				
Av. alkylate facilities, bbl. per day	1,000	Planned	.....	.....
Benzene facilities, bbl. per day	750	Planned	.....	.....
Toluene facilities, bbl. per day	390	Planned	.....	.....
Aromatic base facilities, bbl. per day	1,820	Planned	.....	.....
Standard Oil Co. (Ohio), Cleveland:				
Crude-oil distillation unit, bbl. per day	50,000	Building	Early '52	Arthur G. McKee Co.
Standard Oil Co. of Texas, El Paso:				
Cat. cracking unit, bbl. per day	11,000	Planned	.....	Catalytic Construction Co.
Av. alkylate facilities, bbl. per day	940	Planned	.....	.....
Stanolind Oil & Gas Co., Vivian (Superior), La.:				
Reforming unit, bbl. per day	1,200	Building	.....	.....
Sun Oil Co., Marcus Hook, Pa.:				
Cat. reforming, bbl. per day	11,000	Planned	.....	.....
Av. alkylate facilities, bbl. per day	850	Planned	.....	.....
Benzene facilities, bbl. per day	550	Planned	.....	.....
Toluene facilities, bbl. per day	1,000	Planned	.....	.....
Aromatic base facilities, bbl. per day	1,800	Planned	.....	.....
Sunland Refining Corp., Fresno, Calif.:				
Thermal cracking, bbl. per day	900	Planned	.....	.....

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While the Bank is prepared to provide all available information on the oil industry, it does not make recommendations in regard to the purchase of individual oil stocks.

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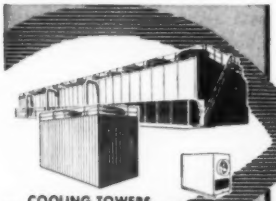
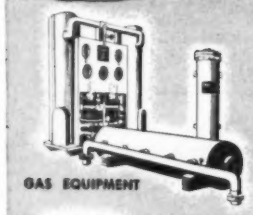
ACTIVE REFINERY-BUILDING PROJECTS (Continued)

Company, location, and type of project—	Capacity rating	Status	Comp. schedule	Contractors
Snuray Oil Corp., Duncan, Okla.:				
Modernize cat. poly plant		Planned		
Av. alkylate facilities, bbl. per day	2,100	Planned		
Sunset Oil Co., Torrance, Santa Fe Springs, Calif.:				
Thermal cracking unit, bbl. per day	2,500	Building		
Taylor Refining Co., Corpus Christi, Tex.:				
Cat. cracker, bbl. per day	8,000	Building	Mid '51	The Lummus Co.
Cat. poly unit, bbl. per day	400	Building	Mid '51	The Lummus Co.
Crude unit, bbl. per day	20,000	Building	Mid '51	Taylor Refining Co.
Gas-recovery unit		Building	Mid '51	The Lummus Co.
Taylor Refining Co. and Mayfair Minerals, Inc., Port Isabel, Tex.:				
Platforming unit, bbl. per day	4,000	Building	Mid '51	Universal Oil Products Co.
Texas Co., The, Lawrenceville, Ill.:				
Increase crude capacity, bbl. per day	20,000	Building	Mid '51	Foster Wheeler Corp.; M. W. Kellogg Co.
Cat. cracker		Building	Mid '51	
Cat. poly unit		Building	Mid '51	
Atmospheric unit		Building	Mid '51	
Vacuum unit		Building	Mid '51	
Uinta Oil Refining Co., Vernal, Utah:				
Cat. cracker		Planned		
Union Oil Co., Edmonds, Wash.:				
New asphalt refinery, bbl. per day	4,000	Building	1951	Bechtel Corp.
Union Oil Co. of California, Los Angeles:				
Cat. cracking unit, bbl. per day	28,500	Building	1952	Arthur G. McKee & Co.; Universal Oil Products Co.
Crude units, bbl. per day	40,000	Building	1952	Fluor Corp., Ltd.
Vacuum flasher, bbl. per day	35,000	Building	1952	Fluor Corp., Ltd.
Redistillation unit, bbl. per day	15,000	Building	1952	C. F. Braun & Co.
Utah Oil Refining Co., Salt Lake City:				
Increase boiler plant, lb. per hour	65,000	Contracted	Late '51	Stearns-Roger Mfg. Co.
Western Oil & Fuel Co., Superior, Wis.:				
New refinery, bbl. per day	10,000	Planned	.....	.....
Western States Refining Co., Salt Lake City:				
Crude-oil expansion, bbl. per day	3,000	Planned	.....	.....
Cat. cracking, bbl. per day	2,200	Planned	.....	.....
Wickett Refining Co., Wickett, Tex.:				
Thermal cracking unit, bbl. per day	1,200	Building	Late '51	
Reforming unit, bbl. per day	800	Building	Late '51	
Wilcox Oil Co., Bristow, Okla.:				
Cat. reforming, bbl. per day	1,500	Planned	.....	.....
Wood River Oil & Refining Co., Calumet City, Ill.:				
Crude-oil capacity, bbl. per day	15,000		.....	.....
Cat. cracking, bbl. per day	6,800		.....	.....





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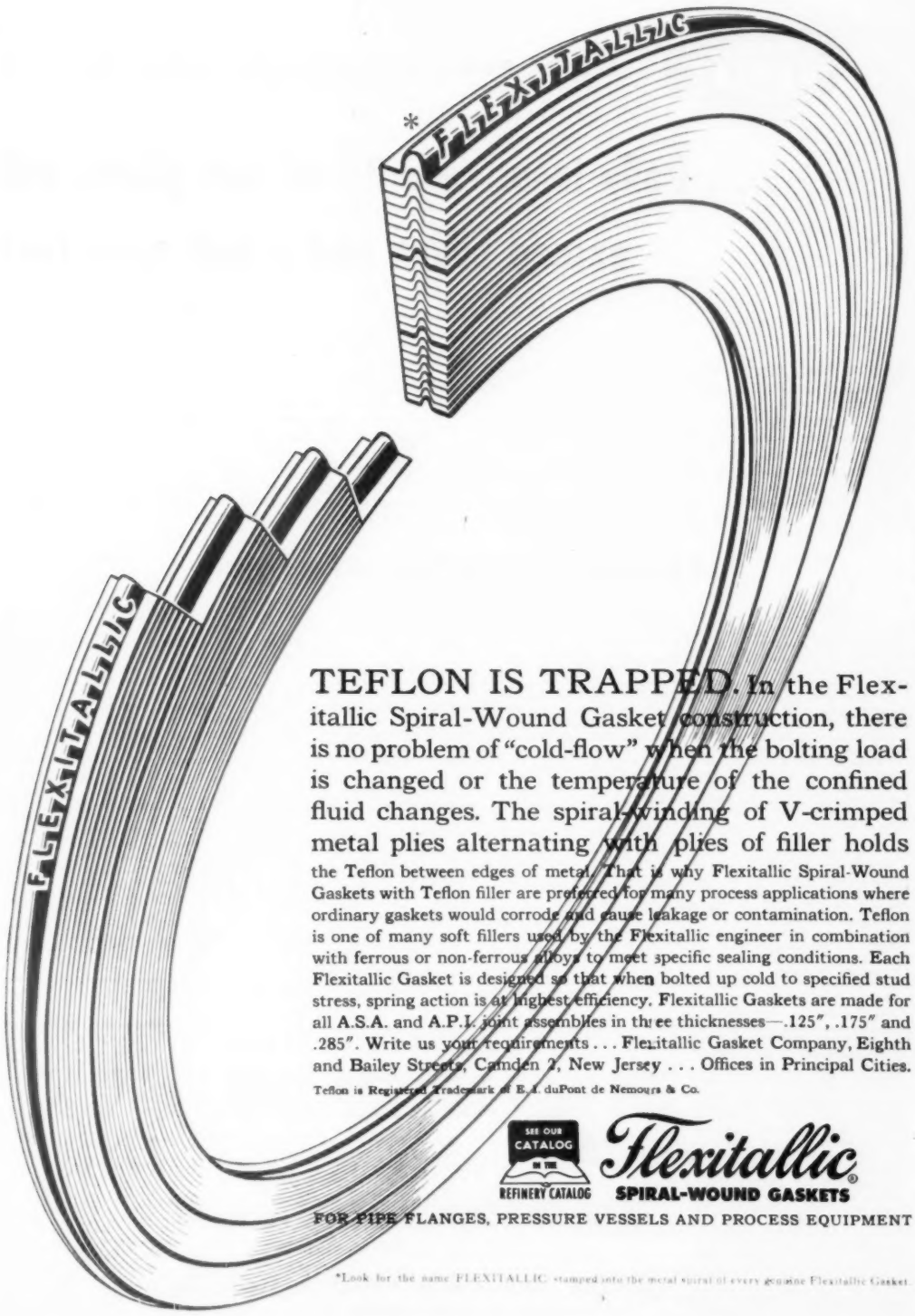

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MIDYEAR REPORT

FIELD PROCESSING-PLANT CONSTRUCTION

. . . Daily input capacity of new plants will exceed billion and a half cubic feet

By R. B. TUTTLE

MORE than 1,500,000,000 cu. ft. of daily input capacity is included in the design ratings of the natural-gasoline plants under construction at the midperiod of the year. In addition to this group of new field processing plants are seven projects planned and under way for increasing plant capacity. Total capacity increase for these projects is estimated at 500,000 gal. daily. One new gasoline plant and one large plant expansion are still in the planning stage. Both of these projects are scheduled for Texas areas. A new cycling plant is planned for erection in Louisiana and another in Texas is being expanded to 70,000,000 cu. ft. daily.

Production capacity of the three building and one planned sulfur-recovery installations totals 155 tons daily. Three of these plants are located in Texas and the other in Arkansas. One new carbon-black plant is under construction in Louisiana. Texas is scheduled to have four new carbon-black plants including one which is on active planned status and one that is authorized for immediate construction.

Natural-Gas Processing-Plant Building Projects

Company, location, and type of project	Capacity rating	Status	Comp. schedule	Contractors
Abercrombie, J. S., Co., Old Ocean field, Texas:				
Dehydration plant, cu. ft. per day	100,000,000	Planned	Late '51	
American Petrochemical Corp., Lake Charles, La.:				
Petrochemical plant		Proposed		
Arkansas Fuel Oil Co., Waskom, Tex.:				
Increase plant pressure and add dehydration, cu. ft. per day	60,000,000	Building	Mid '51	Arkansas Fuel Oil Co.
Atlantic Refining Co., Beauregard Parish, Louisiana:				
Addition compressor and air-cooling facilities		Building	1951	
California Co., The, Rangely, Colo.:				
Expansion, gal. per day	65,000	Planned	1951	
Commercial Solvents Corp., Sterlington, La.:				
Ammonia plant		Building		
Continental Oil Black Co., Lake Charles, La.:				
Carbon-black plant		Building		
Dow Chemical Co., Freeport, Tex.:				
Plant enlargement		Building		
E. I. du Pont de Nemours & Co., Victoria, Tex.:				
Petrochemical plant		Building		
El Paso Natural Gas Co., San Juan, N. M.:				
Gasoline plant, gal. per day	54,000	Building	1951	
General Atlas Carbon Co., Big Spring, Tex.:				
Carbon-black plant		Planned		
General Crude Oil Co., Esperson Dome, Texas:				
Pressure-maintenance plant, hp.	330	Building	Early '51	O. L. Olsen Co.
Great Lakes Carbon Co.:				
Capacity increase		Planned	1952	
Gulf Oil Corp., St. Landry Parish, Louisiana:				
Cycling plant, cu. ft. per day	125,000,000	Planned	Early '53	
J. M. Huber Corp., Baytown, Tex.:				
Carbon-black plant, lb. per year	30,000,000	Building		Stearns-Roger Mfg. Co.
Hugoton Plains Gas & Oil Co., Hooker, Okla.:				
Gasoline plant, cu. ft. per day	110,000,000	Building		
Hugoton Producing Co., Ulysses, Kans.:				
Gasoline plant, cu. ft. per day	65,000,000	Building		
La Gloria Corp., Jim Wells, Tex.:				
Expand compressor plant		Building		
Dehydration plant		Building		
Lion Oil Co., Magnolia, Ark.:				
Sulfur-recovery unit, tons per day	10	Building	Mid '51	R. A. Graff
Lion Oil Co., Scurry County, Texas:				
Gasoline plant, gal. per day	313,500	Building	1951	Hudson Engineering Co.
Lone Star Gas Co., Bronte, Tex.:				
Desulfurization unit, cu. ft. per day	10,000,000	Building	Early '51	R. A. Graff
Matheson Chemical Co., Houston:				
Fertilizer plant		Building		
Matheson Hydrocarbon Chemical Co., Brandenburg, Ky.:				
Petrochemical plant		Building	Late '51	E. B. Badger & Sons Co.; Stone & Webster Const. Co.
Monsanto Chemical Co., Texas City, Tex.:				
Petrochemical-plant expansion		Building		
Odessa Natural Gasoline Co., Odessa, Tex.:				
Sulfur-recovery plant, tons	20	Planned		

NATURAL-GAS PROCESSING-PLANT BUILDING PROJECTS (Continued)

Company, location, and type of project—	Capacity rating	Status	Comp. schedule	Contractors
Ohio Fuel Gas Co., Medina, Ohio:				
Increase absorber capacity, gal. per day	1,000	Planned		
Ohio Oil Co., North Markham, Tex.:				
Gasoline-pressure-maintenance plant, cu. ft. per day	90,000,000	Contracted	Early '52	Hudson Engineering Co.
Pecos Petroleum Co., Orla, Tex.:				
Enlarge gasoline plant, gal. per day	30,000	Building		
Phillips Chemical Co., Goldsmith, Tex.:				
Sulfur plant, tons daily	100	Planned	1951	
Phillips Chemical Co., Phillips, Tex.:				
Carbon-black plant, tons per year	80,000	Authorized		
Phillips Petroleum Co., Brazoria County, Texas:				
Gasoline plant, cu. ft. per day	175,000,000	Building		
Phillips Petroleum Co., Spraberry field, Texas:				
Gasoline plant, cu. ft. per day		Planned		
Plymouth Oil Co., San Patricio, Tex.:				
Addition of compressor unit		Building	1951	
Pontiac Refining Co., and The Chicago Corp., Corpus Christi, Tex.:				
Petrochemical plant		Authorized		
Richfield Oil Corp., Kern County, California:				
Gas-injection unit, cu. ft. per day	24,000,000	Building	1951	
Richfield Oil Corp., Santa Barbara County, California:				
Expand gas-processing cap., cu. ft. per day	10,000,000	Building	1951	
Expand gas-injection cap., cu. ft. per day	8,000,000	Building	1951	
Shell Oil Co., Operator, Elk City, Okla.:				
Expand plant		Planned	1952	
Sid Richardson Gasoline Co., Winkler County, Texas:				
Addition compressor and generating units		Building	1951	
L.P.G. underground storage, bbl.	50,000	Building	1951	
Sulfur-recovery unit, tons per day	25	Building	1951	
Southern Production Co., Brazoria County, Texas:				
Revamp vapor-recovery plant		Proposed		
Standard Oil Co. of Calif., Operator, Unit Operation, Naval Petroleum Reserve No. 1, Elk Hills, Calif.:				
Enlarge booster compressor unit		Planned		
Processing plant, cu. ft. per day	50,000,000	Planned		
Stanolind Oil & Gas Co., Grant, Kans.:				
Expand gas capacity, cu. ft. per day	325,000,000	Planned	1951	
Expand liquid capacity, gal. per day	283,000	Planned	1951	
Stanolind Oil & Gas Co., Nueces, Tex.:				
Expand gas capacity, cu. ft. per day	37,000,000		1951	
Expand liquid capacity, gal. per day	55,000		1951	
Sun Oil Co., Delhi, La.:				
Isobutane facilities, bbl. per day	197	Planned		
Sun Oil Co., Richland Parish, Louisiana:				
Additional recovery and separation facilities		Planned		
Superior Oil Co., Colorado County, Texas:				
Gasoline plant, cu. ft. per day	60,000,000	Building	Mid '51	Brown & Root Const. Co.
Taylor Refining Co. and Mayfair Minerals, Inc., McAllen, Tex.:				
Cycling-plant expansion, cu. ft. per day	70,000,000	Building	Late '51	Gasoline Plant Const. Co.
Tennessee Gas Transmission Co., Greenburg, Ky.:				
Gasoline plant, cu. ft. per day	600,000,000	Building	Mid '51	
Texas Co., The, Scurry County, Texas:				
Gasoline plant, cu. ft. per day	15,000,000	Building	Late '51	
Tex-Harvey Gasoline Co., Midland County, Texas:				
Gasoline plant, cu. ft. per day	35,000,000	Planned		
Warren Petroleum Co. (operator), Garvin County, Oklahoma:				
Gasoline plant increased capacity, cu. ft. per day	200,000,000	Building		
Warren Petroleum Co. et al, Major County, Oklahoma:				
Gasoline plant, cu. ft. per day	50,000,000	Contracted		

MIDYEAR REPORT

PIPE-LINE CONSTRUCTION

. . . Projects Completed and Under Way Total 18,480 Miles of Pipe Line

By PAUL REED

THE scale on which pipe-line construction has been carried in the first half of 1951 is consistent with the high level of activity in the two preceding years. Projects completed and under way throughout the world so far this year total 18,480 miles. Of this amount 15,470 miles are in the United States, 3,010 miles are abroad.

In the United States, crude-oil projects completed in 1951 total 1,100 miles, those under way 1,150 miles. Domestic products projects completed this year total 1,050 miles; and those under way 1,570 miles. Natural-gas projects completed in the first half total 2,400 miles; and under way 8,200 miles.

Foreign construction includes 270 miles of crude-oil and natural-gas projects completed this year and approximately 2,740 miles under way.

The largest current foreign pipe laying is for crude-oil projects totaling 1,300 miles. Foreign crude-oil lines planned and under consideration total 3,600 miles. Products lines being built abroad total 490 miles while those planned amount to 1,200 miles. Natural-gas lines under way in foreign countries total 950 miles; gas projects planned for the future amount to 5,400 miles.

The 26,300 miles of pipe lines planned and under consideration for domestic and foreign projects is consistent with programs for the last two years which have resulted in pipe laying at rates of between 19,000 to 20,000 miles per year for petroleum and natural-gas lines. Proposed and domestic lines include 2,600 miles for crude oil, 1,700 for products and 11,800 for natural gas. Foreign proposals are for 3,600 miles of crude oil lines, 1,200 miles of products lines and 5,400 miles of natural gas.

These figures for foreign proposed lines include several crude-oil and natural-gas projects in western Canada which are competing for government permits which would naturally result in some elimination.

However, the magniture of undertakings involved in proposed projects to meet the growing needs of the petroleum and natural-gas industries promises that pipe laying will continue at close to the 20,000-mile annual rate when restrictions are removed.

Restrictions in the availability of line pipe are threatening drastic reduction of pipe laying in the last half of this year. However, experience in World War II indicates that some alleviation may be expected to meet requirements of the country. Pipe lines make important contributions to national efficiency vital for a defense program.

Crude-oil lines are now operating at close to full capacity. Inadequate allocation of pipe, in diameters of 6 in. and smaller, points to the need or provisions for gathering-line connections with wells for which casing has been already allotted. Products lines relieve railroad traffic. Considerable construction remains for completing unfinished natural-gas lines in order to provide for effective utilization.

Billion-Dollar Crude-Line Program

Expenditures of $1,000,000,000 have been forecasted for construction to provide for additional long crude-oil pipe-line capacity for increased demand of 2,000,000 bbl. daily which has been predicted in a rise from the 6,500,000-bbl.-daily average of 1950 to 8,650,000 bbl. daily expected as the domestic demand for 1960. Demand increase of a million barrels from 1950 to 1955 would call for $500,000,000 for such crude-oil-line facilities in a 5-year period.

New crude-oil lines regarded as highly essential for the defense effort will be given allocations of pipe in the fourth quarter. Among those projects are two big-inch lines from West Texas: (1) West Texas Gulf Pipe Line Corp.'s 581 miles of 20, 24, and 26-in. to Longview and Sour Lake, Tex., and (2) Rancho Pipe Line System's 477 miles of 24-in. to Deer Park and Texas City, Tex. Included in this essential program are also Platte Pipe Line Co.'s 1,075-mile, 16-20-in. now under way from Worland, Wyo., to Wood River, Ill.; Ohio Oil Co.'s 117-mile big-inch extension from Sheridan, Ind., to Lima, Ohio; Sinclair Pipe Line Co.'s 674-mile, 22-in. from Drumright, Okla., to East Chicago, Ind.; and the enlargement of a system to move Louisiana oil.

Building of Sinclair's new Drumright-East Chicago line will make possible the removal of small-diameter parallel lines estimated to amount to approximately twice the tonnage of the big-inch pipe for the new project.

The prospects for laying a long crude-oil line in western Canada this summer have been dimmed by delays in dominion-government action. It appears now that the matter will be considered in hearings in September. A few weeks ago it was anticipated that quick action would be taken in June to facilitate starting construction this summer of this line which would extend from Edmonton, Alta., to Vancouver, B. C. Four companies applied for permits.

Table 1—Principal Domestic Crude-Oil Projects Planned and Under Way

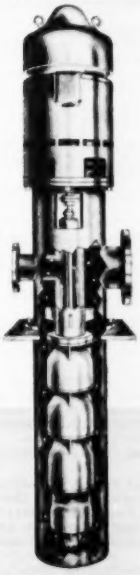
Company—	Miles	Inch	Status	Contractor, location, and completion date
Gulf Refining Co.	64	10	Authorized	Eucutta to Lumberton. 1-1-52.
Gulf Refining Co.	87	14	Authorized	Lumberton to Mobile. 1-1-52.
Interstate Oil Pipe Line Co.	35½	12	Under way	Houston Contracting Co.—New Iberia to Sunset, La.
Interstate Oil Pipe Line Co.	20	6-8	Under way	Houston Contracting Co.—New Iberia to Weeks Island and Avery Island fields.
Phillips Pipe Line Co.	27	8	Authorized	Looping from Yale, Okla., to Thrall, Kans.
Phillips Pipe Line Co.			Authorized	Midland, Glasscock, Reagan, and Upton counties.
Platte Pipe Line Co.	1,075	16-20	Contracted	Worland, Wyo., to Wood River Ref. area in Illinois.
Platte Pipe Line Co.	573	16-20	Under way	R. H. Fulton & Co. (Sections 1, 2, 3, 4).—Worland, Wyo., to Holdredge, Neb.
Platte Pipe Line Co.	142	20	Under way	Bishop & Lock (Section 5).—Near Marysville, Kans., to Holdredge, Neb.
Platte Pipe Line Co.	100	20	Contracted	Rumsey Bros. (Section 6).—Northern edge of Kansas.
Platte Pipe Line Co.	274	20	Contracted	O. R. Burden (Sections 7-8).—State of Missouri.

Boiling point temperatures and limited NPSH pose no problem for these VMT pumps!

WHEN PUMPING FLUIDS at boiling point temperatures, the problem of sufficient net positive suction head often requires expensive installation to raise the vessel from which the pump would draw or to excavate a pit to lower the pump.

This is eliminated with the BJ "VMT" pump because the vertical multi-stage pumping unit is mounted in a barrel from which it takes a suction. The base of the pump is at ground level while the length of the barrel is determined by the NPSH requirement.

The "VMT" pumps (shown above) serving as boosters from gasoline tank farm to main line stations are just one of the many successful applications for refineries, pipe lines, fueling stations, power plants, and process industries. For more detailed information on how the "VMT" may solve your pumping problem, call your local BJ sales office or send the coupon below.



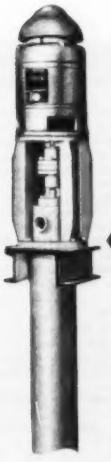


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TABLE 1—PRINCIPAL DOMESTIC CRUDE-OIL PROJECTS PLANNED AND UNDER WAY (Continued)

Company—	Miles	Inch	Status	Contractor, location, and completion date
Platte Pipe Line Co.	155	20	Under way	O. R. Burden.—Salisbury to St. Louis. 9-15.
Platte Pipe Line Co.	125	20	Under way	O. R. Burden.—Salisbury to St. Joseph, Mo. 9-15.
Progress Co.	900	20	Proposed	Permian basin, West Texas, to California.
Service Pipe Line Co.	135	8-10	Planned	Old Glory field to Bowie, Tex.
Sinclair Pipe Line Co.	674	22	Authorized	Drumright, Okla., to East Chicago, Ind.
Texas-New Mexico Pipe Line Co.	75	8	Planned	Midland to Germania pool; Midland to Scarborough and Sweetie Peck area; and Crane Sta., to McElroy area, West Texas.
Texas-New Mexico Pipe Line Co.	55	8	Planned	Eunice to Covington and Sauders area, New Mexico.
West Texas Gulf Pipe Line Corp.	467	26-24	Authorized	West Texas to Gulf Coast—26-in. Colorado City to Wortham, Tex.; 24-in. Wortham to Sour Lake, Tex. 10-52.
West Texas Gulf Pipe Line Corp.	114	20	Authorized	Wortham to Longview, Tex. 10-52.

TABLE 2—PRINCIPAL DOMESTIC PRODUCT PROJECTS PLANNED AND UNDER WAY

Bell Oil & Gas Co.	150	6	Planned	Ardmore to Drumright, Okla.
Buckeye Pipe Line Co.	430	14	Begin 1952	Linden, N. J., to Allentown, Pa., on to New York State. 1953.
Ohio Oil Co.	24	8	Authorized	East St. Louis to Wood River, Ill.
Phillips Petroleum Co.	163	12	Under way	Looping from Borger, Tex., to Paola, Kans. 11-1-51.
Phillips Petroleum Co.	137	10	Under way	Looping from Paola, Kans., to E. St. Louis, Ill. 11-1-51.
Phillips Petroleum Co.	198	8	Under way	Looping from E. St. Louis, Ill., to E. Chicago, Ind. 11-1-51.
Plantation Pipe Line Co.	707	14-18	Under way	Williams Bros.—Baton Rouge to Charlotte, N. C.
Plantation Pipe Line Co.	275	14	Under way	Williams Bros.—Bremen to Charlotte. 1951.
Plantation Pipe Line Co.	432	18	Under way	Williams Bros.—Baton Rouge to Bremen, Ga. 1951.
Plantation Pipe Line Co.	220	18	Contracted	Williams Bros.-Davis Co.—Baton Rouge, La., to Miss.-Ala. state line.
Plantation Pipe Line Co.	126	18	Under way	Williams Bros.—Collins, Miss., to Baton Rouge, La. 8-31.
Plantation Pipe Line Co.	150	18	Under way	Williams Bros.—Moundville, Ala., to Collins, Miss. 8-31.
Plantation Pipe Line Co.	200	14	Under way	Williams Bros.—Windor, Ga., to Charlotte, N. C. 10-1-51.
Progress Co.	900	10	Proposed	California to West Texas.
Salt Lake Pipe Line Co.			Proposed	Pasco, Wash., to Puget Sound.
Standard Oil Co. (Ind.)	144	8	Under way by fall	Neodesha, Kans., to Sugar Creek, Mo. 1-52.
Triangle Pipe Line Co.	85	10	Under way	Anderson Bros. Corp.—El Dorado, Ark., to point on Mississippi River.
Tuscarora Oil Co., Ltd.	61	10	Contracted	Pipe Line Const. & Drilling Co.—Knappenberger to Midland, Pa.
Tuscarora Oil Co., Ltd.	25	10	Under way	Indiana, Pa.
U. S. Army Engineers	190	6⅝	Under way	Associated Pipe Line Contractors, Inc.—Searsport to Limestone, Me. 10-15-51.

TABLE 3—PRINCIPAL DOMESTIC NATURAL-GAS PROJECTS PLANNED AND UNDER WAY

Algonquin Gas Transmission Co.	276		Proposed	Greenwich, Conn., to Boston area.
Algonquin Gas Transmission Co.	492		Proposed	Laterals-New England area.
Associated Natural Gas Co.	88		Planned	Missouri.
Carolina Natural Gas Corp.	185	2-12	Proposed	Lateral lines off Transcontinental in North and South Carolina.
Cities of Booneville and Baldwin, Miss.	96	3-4-6	Under way	M. L. Hulcher Co., Inc.—Booneville and Baldwin, Miss. 11-1-51.
Cities Service Gas Co.	179	4-30	Under way	Vaughn & Taylor Const. Co., Inc.—vicinity of Ulysses. 10-1-51.
Cities Service Gas Co.	66	6-7-8-10	Under way	Knupp Construction Co., Inc.—Reclaim Hutchinson to Wichita, Kans.
City of Florence, Ala.	120	2-8	Under way	Modern Welding Co., Inc.—Alabama. 9-1-51.
Coast Counties Gas & Electric Co.	40	3-4-8	Considered	Coast and Valley region, California.
Colorado Interstate Gas Co.	215	20	Planned	Texas Panhandle to Colorado.
Commonwealth Natural Gas Corp.	537	20	Proposed	West Bend, Ky., to Norfolk, Va.
Dow Chemical Co.	70	various	Under way	Area of Midland, Saginaw and Bay City, Mich.
East Ohio Gas Co.	65	26	Under way	Williams Bros. Corp.—Near Petersburg, to Cleveland, Ohio. 12-1-51.
East Tennessee Natural Gas Co.	172	22	Proposed	Greenbrier to Oak Ridge, Tenn.
Egyptian Natural Gas Co.	80	6-8	Authorized	Norris City to Salem, Ill. 1951.
El Paso Natural Gas Co.	470	24	Under way	San Juan Basin, N. M., to Franconia, Ariz. 10-1-51.
Grand Valley Pipe Line Co.	105	8-10	Contracted	Piceance Creek field to Rifle on to Grand Junction
Gulf Michigan Transmission Corp.	680	30	Proposed	Perryville, La., across, Arkansas, Missouri, and Illinois to terminus near St. John, Inc.
Hope Natural Gas Co.	32		Proposed	Fairmont to Terra Alta, W. Va.
Hugoton Production Co.	55	4-22	Under way	Reese Bros. Const. Co.—Near Ulysses, Kans., gathering system.
Interstate Power Co.	26	8	Proposed	From Natural Gas P. L. Co. of America line near Hooppole, Ill., to Clinton, Ia.
Kansas-Nebraska Natural Gas Co., Inc.	65	2-8	Planned	Big Springs field to Ogallala, Nebr., and to Ovid, Colo.
Kansas-Nebraska Natural Gas Co., Inc.	40	6	Under way	Jayhawk Const. Co.—Albion to Norfolk, Neb. 8-51.
Kansas-Nebraska Natural Gas Co., Inc.	39	4-6⅝	Authorized	Neligh to O'Neill, Neb. 1952.
Kansas-Nebraska Natural Gas Co., Inc.	54½	4½-6⅝	Authorized	Neligh to Hartington, Neb. 1952.
The Kansas Power & Light Co.	10	8	Authorized	Parallel 6-in. north from Larned, Kans.
The Kansas Power & Light Co.	27	20	Authorized	Pratt, Kans., to Calista Comp. Sta.
The Kansas Power & Light Co.	9	16	Authorized	Parallel 16-in. northeast of McPherson, Kans.
Manufacturers Light & Heat Co.	66	16		Britton Contracting Co.—Berwindale to near Hyner, Pa. 8-1-51.
Manufacturers Light & Heat Co.	35	16	Under way	Britton Contracting Co.—Berwindale to Clearfield Co., Pa. 8-1-51.
Manufacturers Light & Heat Co.	31	16	Under way	Britton Contracting Co.—East Bank of Moshannon Creek to near Hyner, Pa. 8-1-51.
Manufacturers Light & Heat Co.	78	16	Contracted	Britton Contracting Co.—Berwindale, Pa., to near Saltsburg, Pa.
Michigan Consolidated Gas Co.	180	24	Planned	Austin, Mich., to Detroit.

TABLE 3—PRINCIPAL DOMESTIC NATURAL-GAS PROJECTS PLANNED AND UNDER WAY (Continued)

Company—	Miles	Inch	Status	Contractor, location, and completion date
Michigan Consolidated Gas Co.	31	24	Under way	Anderson Bros. Corp.—Austin Storage Fields to Lincoln Storage Field, Mich. 8-15-51.
Michigan Consolidated Gas Co.	131	24	Under way	Anderson Bros. Corp.—Austin Storage Fields to Detroit, Mich. 11-1-51.
Mississippi River Fuel Corp.	40	18	Authorized	Dubach to Perryville, La.
Mississippi River Fuel Corp.	98	18-16	Authorized	Feeder line from Lincoln Parish, La., to Waskom Field, Harrison Co., Tex.
Missouri Central Gas Co.	30	6	Authorized	L. R. Young Const. Co.—Moberly to Macon, Mo. 8-1-51.
National Utilities Co. of Michigan	76.7	20	Proposed	South Central Michigan (22 miles from near Marshall south to Coldwater; 20 miles east to Hillsdale; 22 miles southwest to Sturgis; 5 miles from Hillsdale to Jonesville and 6 miles west to Union City).
Nevada Natural Gas Pipe Line Co.	114		Proposed	Topock, Ariz., to Las Vegas, Nevada.
New River Gas Co.	50		Planned	Summers to Monroe counties, W. Va., to Narrows and Dublin, W. Va.
New York State Natural Gas Corp.	62	20	Under way	Williams-Austin Co.—Murrysville, Pa., to Petersburg, Ohio. 12-31-50.
New York State Natural Gas Corp.	164	16	Contracted	Williams-Austin Co.—Ithaca to Albany, N. Y.
New York State Natural Gas Corp.	82½	20	Under way	Williams-Austin Co.—Utica to Ithaca, N. Y. 11-15-51.
New York State Natural Gas Corp.	85	16	Contracted	Williams-Austin Co.—Utica to Albany, N. Y.
New York State Natural Gas Corp.	23	20	Contracted	Williams-Austin Co.—State line sta., to Angelica, N. Y. 10-51.
New York State Natural Gas Corp.	26	30	Authorized	New Kensington to South Bend, Pa.
New York State Natural Gas Corp.	51	20	Authorized	New Kensington, Pa., to Ohio line.
New York State Natural Gas Corp.	37	20	Under way	Boome storage field to Ithaca, N. Y. 10-25-51.
New York State Natural Gas Corp.	27	16	Authorized	Looping in Greene and Westmoreland counties.
New York State Natural Gas Corp.	70	20	Authorized	No. Oakford, Pa., to Ohio state line.
New York State Natural Gas Corp.	39	20	Authorized	Potter County, Pennsylvania, to Livingston and Monroe counties, New York.
New York State Natural Gas Corp.	77	20	Under way	Williams Bros.—Indiana, Pennsylvania., to Petersburg, Ohio. 10-31.
New York State Natural Gas Corp.	65	26	Authorized	Ohio-Pennsylvania state line northwesterly to Summit County, Ohio.
Niagara Mohawk Power Corp.	40	10-12-16	Under way	Williams-Austin Co.—lateral lines to Utica, N. Y.
Niagara Mohawk Power Corp.	55	10	Under way	Williams-Austin Co.—Fulton to Watertown, N. Y.
Northeastern Gas Transmission Co.	511	20-24	Authorized	New Hampshire, Massachusetts, and Connecticut.
Northeastern Gas Co.	411		Proposed	New England towns.
Northern Indiana Fuel & Light Co.	33	8	Proposed	Edgerton to Auburn, Ind.
Northern Natural Gas Co.	580		Proposed	Loops in Kansas, Texas, Oklahoma and Nebraska.
Northern Natural Gas Co.	370	4-26	Authorized	Gathering lines Hugoton field.
Northern Natural Gas Co.	210	26	Proposed	Five loops—Texas-Oklahoma, two in Kansas, two in Nebraska.
Northern Natural Gas Co.	217	26	Under way	G. G. Griffis Const. Co.—Palmyra, Neb., to Skellyville, Tex.
Northern Natural Gas Co.	181	4 to 12	Contracted	Reese Bros. Const.—gathering lines in Hugoton field.
Northwest Natural Gas Co.	750		Planned	Washington, Oregon, and Idaho.
Ohio Fuel Gas Co.	61		Proposed	Northern and southwestern Ohio; 16 mi., in Erie Co.; 8 in Warren and Montgomery Cos.; 13 in Madison Co.; 23 in Lorain Co.
Ohio Fuel Gas Co.	22	16	Authorized	Dayton, Troy, Piqua, and Sidney.
Ohio Fuel Gas Co.	74	3 to 20	Authorized	Hocking, Knox, and Ashland counties.
Ohio Fuel Gas Co.	47	20	Authorized	Benton Township, Hocking County, to Columbus Ohio.
Oklahoma Natural Gas Co.	40	16	Under way	Ninnekah to County Line, Okla.
Oklahoma Natural Gas Co.	26	12	Authorized	Ringwood to Enid. 1-52.
Oklahoma Natural Gas Co.	40	2-36	Authorized	Ringwood field gathering system. 1-52.
Pacific Gas & Electric Co.	141	34	Proposed	Parallel sections along Topock-Milpitas line.
Pacific Gas & Electric Co.	44	8	Under way	Salinas to King City.
Pacific Northwest Pipe Line Corp.	400	22		Gathering lines on Texas Gulf Coast to Pacific Northwest Pipeline.
Pacific Northwest Pipe Line Corp.	2,175	26	Authorized	Wharton Co., Tex., via. Okla., Kans., Fort Collins, Colo., to Portland, Ore., Tacoma and Seattle, Wash.
Panhandle Eastern Pipe Line Co.	174	30-26	Contracted	R. A. Conyes.—Tuscola, Ill., eastward—looping present system.
Panhandle Eastern Pipe Line Co.	44	26	Contracted	Anderson Bros.—looping on present system—Edgerton, Mich.
Panhandle Eastern Pipe Line Co.	22	30	Contracted	R. A. Conyes.—looping in Tuscola, Ill.
Panhandle Eastern Pipe Line Co.	45	30	Contracted	R. A. Conyes.—looping in Montezuma, Ind.
Panhandle Eastern Pipe Line Co.	63	30	Contracted	R. A. Conyes.—Zionsville, Ind.
Pennsylvania Gas Co.	52	12	Under way	Harford Bros.—Between Warren and Erie, Pa.
Phillips Petroleum Co.	118	3-22	Under way	Vaughn & Taylor Const. Co., Inc.—Sherman and Hansford counties, Texas, gathering system.
Piedmont Natural Gas Co.	28	6	Proposed	North Carolina—laterals from Transcontinental Gas System.
Prince George's Gas Corp.	20	22	Authorized	Between Chillum and Rockville, Md.
Southern California Gas Co.	22¼	22	Under way	Joe E. Young Pipeline Const. Co.—Simi to Santa Clara River. 9-51.
Southern California Gas Co.	24	30	Under way	Alex Robertson Co.—Inglewood to San Fernando Valley. 11-51.
Southern California Gas Co.	35		Planned	Antelope Valley.
Southern Natural Gas Co.	169		Proposed	Ouachita Parish, La., to Augusta, Ga.
Southern Natural Gas Co.	20		Proposed	Ouachita Parish, La.
Southern Natural Gas Co.	33		Proposed	Ouachita and West Carroll parishes.
Southern Natural Gas Co.	7		Proposed	Sharkey Co., Miss.
Southern Natural Gas Co.	108	14	Proposed	Bass Junction to Augusta, Ga.
Southern Natural Gas Co.	21	24	Authorized	Perryville Sta., La., to Boeuf River.
Southern Natural Gas Co.	14	24	Authorized	Onward Sta., Miss., to Big Sunflower River.
Southern Natural Gas Co.	14	14	Authorized	Perryville Sta., La., to Wilhite Gate.
Southwest Gas Corp., Ltd.	26		Proposed	From Pac. G. E. line to Victorville, Calif.
Sunray Oil Corp.	133	3-30	Under way	Vaughn & Taylor Const.—Snyder Gasoline Plant to Scurry County, Texas.
Sunray Oil Corp.		8	Under way	Refinery Engineering Co.—Allen to Drumright, Okla. 9-51.

TABLE 3—PRINCIPAL DOMESTIC NATURAL-GAS PROJECTS PLANNED AND UNDER WAY (Continued)

Company—	Miles	Inch	Status	Contractor, location, and completion date
Tennessee Gas Transmission Co.	992	30	Planned	First 150 miles of loops to be laid at Monroe, La., Greenville, Miss., Midland and Portland, Tenn.
Tennessee Gas Transmission Co.	438		Planned	Looping on Buffalo and New England extensions.
Tennessee Gas Transmission Co.	528		Proposed	Loops.
Tennessee Gas Transmission Co.	200		Proposed	Loops and miscellaneous laterals.
Tennessee Gas Transmission Co.	419	26-30	Authorized	Looping on presently authorized system.
Tennessee Gas Transmission Co.	142	24		
Tennessee Gas Transmission Co.	200	various		
Tennessee Gas Transmission Co.	175	24	Under way	Oklahoma Contracting Co.—Albany to near Wilmington, Mass.
Tennessee Gas Transmission Co.	156	24	Under way	H. C. Price—Hamburg to Onondaga-Madison county line, N. Y. 8-1-51.
Tennessee Gas Transmission Co.	120	24	Under way	Bechtel Corp.—Hamburg to Hudson River, N. Y. 8-1-51.
Tennessee Gas Transmission Co.	65	30-26	Under way	Oklahoma Contracting Co.—Falfurrias and Victoria, Tex.
Tennessee Gas Transmission Co.	158	30	Contracted	Houston Contracting Co.—Vicinity of Jones, La., on the north to near Cypress, Tex., on the south.
Texas Eastern Transmission Corp.	791	30	Planned	Kosciusko, Miss., to Connellsville, Pa.
Texas Eastern Transmission Corp.	163	30	Under way	Williams Bros.—Davis Co.—Kosciusko, Miss., to Florence, Ala. 10-15-51.
Texas Eastern Transmission Corp.	100	30	Contracted	Mahoney Const.—Kentucky River to Ohio River, northeastern Ky. 10-15-51.
Texas Eastern Transmission Corp.	36	20	Under way	E. J. Mahoney Contr. Co.—Connellsville, Pa., to Oakland Storage Sta. 8-1-51.
Texas Eastern Transmission Corp.	76		Contracted	Eastern Pipe Line Contractors—Tenn. River to Columbia River. 10-1-51.
Texas Eastern Transmission Corp.	73		Contracted	H. B. Zachry Co.—Columbia, Tenn., to Cumberland River. 10-15-51.
Texas Gas Transmission Corp.	33	12	Authorized	Slaughters, Ky., to Evansville, Ind.
Texas Gas Transmission Corp.	189	26	Proposed	Gulf Coast region to Southwestern La. Acadia Parish to connection with existing facilities in Morehouse Parish.
Texas Gas Transmission Corp.	425	26	Proposed	Looping from Bastrop, La., to Hardinsburg, Ky.
Texas Gas Transmission Corp.	642	26	Proposed	Louisiana and Kentucky.
Texas Illinois Natural Gas Pipeline Co.	1,300	30	Authorized	Corpus Christi area to Joliet, Ill.
Texas Illinois Natural Gas Pipeline Co.	100	30	Under way	Midwestern Const., Inc. (Schedule 11)—Mississippi River near Chester, to Effingham, Ill.
Texas Illinois Natural Gas Pipeline Co.	100	30	Under way	Midwestern Const. Co. (Schedule 12)—Effingham to Sibley, Ill. 9-17-51.
Texas Illinois Natural Gas Pipeline Co.	92	30	1951	Midwestern Const. Co. (Schedule 13)—Sibley to Joliet, Ill. 9-4-51.
Texas Illinois Natural Gas Pipeline Co.	409	30	Under way	Bechtel Corp.—Arkansas and Missouri.
Texas Illinois Natural Gas Pipeline Co.	58	20	Under way	Ray L. Smith & Son, Inc.—Joliet, Ill., to Volo Meter Station.
Texas Illinois Natural Gas Pipeline Co.	106	30	Under way	Bechtel Corp.—Tex.-Ark. state line to Malvern, Ark. 10-15-51.
Texas Illinois Natural Gas Pipeline Co.	130	30	Under way	Bechtel Corp.—Malvern, Ark., to Newport, Ark. 10-15-51.
Texas Illinois Natural Gas Pipeline Co.	74	30	Under way	Bechtel Corp.—Newport, Ark., to Moark, Ark. 10-15-51.
Texas Illinois Natural Gas Pipeline Co.	400	30	Contracted	H. C. Price—Trinity River to Texarkana.
Texas Illinois Natural Gas Pipeline Co.	98	30	Under way	H. C. Price—Urbana to Garrison, Tex. 8-29-51.
Texas Illinois Natural Gas Pipeline Co.	96	30	Under way	H. C. Price—Garrison, Tex., to Tex.-Ark. state line. 9-18-51.
Transcontinental Gas Pipe Line Corp.	35½	24	Authorized	Paterson, N. J., lateral to Greenwich, Conn.
Trunkline Gas Co.	1,775	10-26	Under way	Includes 740 mi., 26-in., Lake Charles, La., to Tuscola sta., of Panhandle East. P. L. Co., and 1,035 mi., 10-24-in., Lake Charles, La., to McAllen, Tex. 10-1-52.
Trunkline Gas Co.	176	26	Under way	Houston Contracting Corp. (Section A—Main Line)—Darneil, La., to Longville, La. 2-51.
Trunkline Gas Co.	180	26	Contracted	Anderson Bros. Corp. (Section B—Main Line)—Darnell, La., to Senatobia, Miss.
Trunkline Gas Co.	262	20	Contracted	R. H. Fulton & Co. (Sections E and F), McAllen to Altair, Tex.
Trunkline Gas Co.	184	26	Under way	R. H. Fulton & Co.—Senitoba, Miss., to Joppa, Ill.
Trunkline Gas Co.	217	34	Contracted	Anderson Bros. Corp. (Sections G and H)—Longville, La., to Altair, Tex.
Trunkline Gas Co.	50	26	Contracted	Houston Contracting Co.—Longville to northeast vicinity of Hineston, La.
Trunkline Gas Co.	126	26	Contracted	Houston Contracting Co.—Epps to Hineston, La.
Union Gas & Electric Co.	35	8	Under way	O. R. Burden Contracting Co.—Bloomington, to Harris, Ill., Fall 1951.
United Fuel Gas Co.	29	20	Authorized	Lanham to Broad Run, W. Va.
United Gas Pipe Line Co.	100	20-26-30	Contracted	J. Ray McDermott and Associated Pipe Line Contr., Inc.—Near Houma to Franklin, La.
United Gas Pipe Line Co.	50	16	Authorized	Baldwin Co., Ala., southeasterly to Escambia Co., Fla.
United Gas Pipe Line Co.		30	Contracted	Texas-La. Contractors—Gonzales, La., to Kosciusko, Miss. 11-51.
United Gas Pipe Line Co.		24	Contracted	Texas-La. Contractors—Baxterville, La., to McComb.
United Gas Pipe Line Co.	90	8-10-12-16	Under way	Brown & Root, Inc.—Chalmette to Venice and West Bay Field, La. 9-51.
United Gas Pipe Line Co.	510	20-30	Under way	Gulf Southern Contractors—Agua Dulce, Tex., to Monroe, La.
United Gas Pipe Line Co.	233	20-30	Under way	Gulf Southern Contractors—From Pure Oil Co.'s offshore platform Block 32 Eugene Is. area to Jackson, Miss., comp. sta.
United Gas Pipe Line Co.	42	24	Under way	Gulf Southern Contractors—From Verna Comp. sta., Miss., to Baxterville, Miss., dehydration plant.
United Gas Pipe Line Co.	52	20-24-26	Under way	Gulf Southern Contractors—Lirette to Napoleonville, La., to tie into Eugene Is. Jackson, Miss., 30-in. line.
United Gas Pipe Line Co.	60	12-16-20	Under way	Gulf Southern Contractors—LaFayette Comp. sta. and Weeks Is. field to Franklin, La., to connect with 30-in.

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TABLE 3—PRINCIPAL DOMESTIC NATURAL-GAS PROJECTS PLANNED AND UNDER WAY (Continued)

Company—	Miles	Inch	Status	Contractor, location, and completion date
United Gas Pipe Line Co.	50	30	Under way	Gulf Southern Contractors—Jackson Comp. sta., Miss., to Texas Eastern Trans. Corp. proposed 30-in. line near Kosciusko, Miss.
United Gas Pipe Line Co.	124	..	..	Gulf Southern Contractors—Sterlington Comp. sta. near Monroe, La., to Jackson Comp. sta., Miss.
United Gas Pipe Line Co.	23	8-12-16	..	Gulf Southern Contractors—South Louisiana facilities.
Utah Natural Gas Co.	360	22	Proposed	San Juan Basin area to Salt Lake City.
Virginia Natural Gas Co.	153	..	..	Buckingham to Richmond and Portsmouth, Va.
Westcoast Transmission Co., Ltd.	615	..	Planned	Oregon and Washington.
Western Kentucky Gas Co.	..	2 to 4	Under way	Modern Welding Co., Inc.—addition to present system.
West Texas Gas Co.	27	10	Authorized	Lubbock to Abernathy, Tex.

TABLE 4—PRINCIPAL FOREIGN CRUDE-OIL LINES PLANNED AND UNDER WAY

Alberta Vancouver Oil Pipe Line Co. (Brokaw, Dixon, McKee)	972	16	Proposed	Edmonton via Pincher Creek, Alta., Idaho and Washington states to Vancouver, B. C.
Cia. de Petroleo Ganso Azul, Ltda.	48	4	Planned	Ganso Azul field to Pucallpa on Upper Ucayali River, Peru.
Condor S.p.a. (Shell)	80	..	Planned	Genoa to Rho, near Milan, Italy.
Direccion General de Yacimientos Petroliferos Fiscales	409	..	Under way	Plaza Huincul-Bahia Blanca, Argentina.
Independent Pipe Line Co.	720	16-18-22	Proposed	Edmonton, Alta., to Vancouver, B. C. (185 of 22; 391 of 20; 95 of 16; and 30 of 18).
Iraq Petroleum Co., Ltd.	556	30-32	Under way	Bechtel-Kirkuk—Kirkuk to Banias.
Middle East Pipelines, Ltd.	800	34-36	Considered	Iran-Levantine Port.
Petroleos Mexicanos	145	13	Considered	Reynosa to Monterrey, Mexico.
Petroleos Mexicanos	100	..	Planned	Ismus to Tehuantepec, Jose Colomo to El Plan field, Minatitlan, Mexico.
Shell Caribbean Petroleum Co.	165	30	Under way	Palmarejo to terminals on the Paraguana Peninsula (Cardon and Las Piedras, Venezuela). 12-51.
Shell Caribbean Petroleum Co.	16	14	Under way	Tia Juana to Cabimas, Venezuela (hot oil).
Shell Caribbean Petroleum Co.	10	20	Under way	Mahoney Const. Co.—Across Lake Maracaibo, Venezuela, S. A.
Trans-Mountain Oil Pipe Line Co. (Sponsored by Bechtel)	715	..	Planned	Edmonton, Alta., via Yellowhead Pass to Vancouver, B. C. 1952.
Winnipeg Pipe Line Co., Ltd.	75	10	Under way	Sparling-Fowler Co., Ltd.—Gretna to Winnipeg, Manitoba.

TABLE 5—PRINCIPAL FOREIGN PRODUCTS LINES PLANNED AND UNDER WAY

Colombian Ministry of Petroleum	90	6	Planned	Puerto Berrio-La Dorado, Colombia.
Colombian Ministry of Petroleum	113	6	Contracted	Carolina Construction Co.—Puerto Berrio to Acadedo near Medellin, Colombia.
Colombian Ministry of Petroleum	75	4	Planned	Buena Ventura-Cali, Colombia.
Empresa de Ferrocarriles Ecuatorianos	50	5	Under way	J. A. Jones—Guayaquil to Palmira, Ecuador.
Estrada de Ferro Santos Jundiai	32	10	Under way	Techint—Santos to Sao Paulo, Brazil.
Estrada de Ferro Santos Jundiai	32	18	Under way	Techint—Santos to Sao Paulo, Brazil (fuel oil line).
Governments of Southern Rhodesia and Portuguese East Africa	200	..	Considered	Beira, Portuguese Mozambique to Umtali, Southern Rhodesia.
Imperial Oil Co., Ltd.	195	10-12	Planned	Sarnia to Longon-Hamilton to Toronto.
Petrocongo (Subsidiary Cie. Financiere Belge des Petroles, S. A.)	225	..	Considered	Ango-Ango to Leopoldville, Belgian Congo.
Petroleos Mexicanos	115	10	Under way	Minatitlan to Salina Cruz, Mexico.
Societe des Transports Petroliers par Pipe Line	140	10	Under way	Entrepose—Le Havre to Paris, France—1952.
State of Cundinamarca, Colombia	120	6	..	Williams Bros.—Puerto Salgar to Bogota, Colombia.
Trans-Northern Pipe Line Co.	400	..	..	Hamilton to Toronto to Montreal, Quebec.

TABLE 6—PRINCIPAL FOREIGN NATURAL-GAS LINES PLANNED AND UNDER WAY

Azienda Generale Italiana Petroli	110	12-14-16	Planned	Cortemaggiore to Genoa, Italy.
Azienda Generale Italiana Petroli	110	..	Planned	Cortemaggiore to Bologna, Italy.
Azienda Generale Italiana Petroli	145	14-16	Under way	Cortemaggiore to Torino, Italy. 1951
Canadian Delhi Oil Co.	2,132	..	Proposed	Alberta, Toronto, Montreal.
Direccion General del Gas del Estado	310	8	Under way	Plaza Huincul to Neuquen, Argentina, to the vicinity of General Conesa, Argentina.
Northwest Natural Gas Co.	950	24	Planned	Alberta fields to Vancouver, B. C., Seattle, Wash., and Portland, Oregon.
Northwestern Utilities, Ltd.	35	16	Authorized	Viking to Shonts. 8-31-51.
Petroleos Mexicanos	205	16	Under way	Monterrey to Torreon, Mexico.
Petroleos Mexicanos	260	20	Considered	Monterrey-Tampico-Poza Rica, Mexico.
Petroleos Mexicanos, Mexican Gas Co., and Industrial Gas Co.	600	..	Planned	Reynosa, Tamaulipas, Tampico, Poza Rica, Mexico.
Trans-Canada Pipe Lines, Ltd.	..	..	Proposed	Alberta to Toronto and Montreal.
Union Gas Co. of Canada, Ltd.	61	16	Under way	Shaw Construction Co.—Facilities, Dawn Township, County of Lambton, Province of Ontario.
Venezuela Atlantic Transmission Corp.	195	10-12-16	Under way	Williams Bros. de Venezuela, S. A.—El Placer near Las Merecedes, State of Guarico, to Caracas, La Guaira, Maracay, and Valencia.
Westcoast Transmission Co., Ltd.	1,406	30	Planned	North Alberta, Vancouver, B. C., and Northern Calif.
Western Pipe Lines	1,200	22	Planned	Southern Alberta, Winnipeg, to Duluth, Minn.

TABLE 7—PRINCIPAL DOMESTIC CRUDE-OIL PROJECTS COMPLETED

Company—	Miles	Inch	Contractor, location, and completion date
Arkansas Pipeline Corp.	14	6	Snelling Co.—Oil City, La., to Shreveport-Longview 8-in. line.
Cities Service Pipe Line Co.	13	4	Pecos Co., Tex.
General Petroleum Corp.	40	8	Bechtel Corp.—San Ardo to Estero Bay, Calif. 6-1-51.
General Petroleum Corp.	40	4	Bechtel Corp.—(Cutter stock) Esteros Bay to San Ardo, Calif. 6-1-51.
The Ohio Oil Co.	54	20	Bechtel Corp.—Wood River to Patoka, Ill.

TABLE 7—PRINCIPAL DOMESTIC CRUDE-OIL PROJECTS COMPLETED (Continued)

Company—	Miles	Inch	Contractor, location, and completion date
The Ohio Oil Co.	74	20	R. A. Conyes Const.—Patoka to Martinsville, Ill.
The Ohio Oil Co.	109	22	R. A. Conyes Const.—Martinsville, Ill., to Sheridan, Ind.
Phillips Pipe Line Co.	53	8-6	O. R. Burden Const.—Wheeler to Sweeny, Tex. 1-1-51.
Phillips Pipe Line Co.	278	10	Brown-Lite and Arey-Phillips Co.—Borger, Tex., to Yale, Okla.
Phillips Pipe Line Co.	145	10	Arey-Phillips Co.—Borger, Tex., to Clinton, Okla. 6-1-51.
Phillips Pipe Line Co.	137	10	Brown-Lite Co.—Yale to Clinton, Okla.
Phillips Pipe Line Co.	24	8	C. H. Gragg Const. Co.—Thrall to Kansas City, Kans. 3-1-51.
Sun Pipe Line Co.	23	8	Crossley and Hardy—Snyder area to Basin's Colorado City station.
Texas Pipe Line Co.	56	12	R. H. Fulton & Co.—Wichita Falls to Chico, Wise Co., Tex. 1-15-51.

TABLE 8—PRINCIPAL DOMESTIC PRODUCTS PROJECTS COMPLETED

Great Lakes Pipe Line Co.	355	12	Kansas City through Omaha and Sioux City, Ia., to Sioux Falls, S. D.
Great Lakes Pipe Line Co.	107	8	A. C. Holder Const. and Geneva Const. Co.—Des Moines to Montezuma on to Iowa City, Ia.
Miami-Valley Corp.	58	8	Anderson Bros. Co.—Dayton to Cincinnati, Ohio. 1-1-51.
Phillips Petroleum Co.	50	8	Gragg Construction Co.—looping in Okla., Kans., Mo. 5-1-51.
Plantation Pipe Line Co.	87	18	Williams Bros.-Davis Co.—Moundville, Ala., to Coosa River, Ala.
Pure Transportation Co.	100	6	Wabash Const. Co.—Heath to Dayton, Ohio.
Standard Oil Co. (Indiana)	50	8	Lawhon Const. Co. & Southern Mill & Mfg. Co.—North of Sugar Creek, Mo., refinery.
Texas Pipe Line Co.	56	10	O. R. Burden Const. Co.—Lawrenceville, Ill., to Mt. Vernon, Ind. 7-1-51.
Tuscarora Oil Co., Ltd.	54	10	Pipe Line Construction & Drilling Co.—Knappenberger Scraper Trap to Pittsburgh Junction, Pa.
Tuscarora Oil Co., Ltd.	27	8	Pipe Line Construction & Drilling Co.—Pittsburgh Junction, Pa., to Midland, Pa.
Tuscarora Oil Co., Ltd.	26	10	Pipe Line Const. & Drilling Co.—Barneytown, Pa., to East Freedom, Pa. 7-51.
Tuscarora Oil Co., Ltd.	57	12	Pipe Line Const. & Drilling Co.—Inglenook, Pa., to Tuckerton, Pa. 5-21-51.

TABLE 9—PRINCIPAL DOMESTIC NATURAL-GAS PROJECTS COMPLETED

Cities Service Gas Co.	40	4-10	Knupp Const. Co., Inc.—Liberal, Kans.
Cities Service Gas Co.	29	16	Knupp Const. Co., Inc.—Hesston to Wichita, Kans.
Commonwealth Natural Gas Corp.	99	18	Ray L. Smith—Standardsville to Petersburg, Va.
Commonwealth Natural Gas Corp.	69	12¾	Ray L. Smith—Petersburg to Norfolk, Va.
Commonwealth Natural Gas Corp.	18	8⅝	Ray L. Smith—Suffolk to Newport News, Va.
Commonwealth Natural Gas Corp.	10	8-10-14	Ray L. Smith—Laterals in Richmond, Suffolk, and Portsmouth, Va.
Delhi Oil Co.	68	8	Altgelt Const. Co.—Laredo to Lopeno, Tex.
Equitable Gas Co.	17	16	H. L. Gentry Const.—North of Pittsburgh.
Humble Oil & Refining Co.	42	10	Houston Contracting Co.—Anahuac gasoline plant near Anahuac, Tex., to Gulf States Utilities plant near Beaumont, Tex.
Kansas-Nebraska Natural Gas Co., Inc.	22	12¾	Cheek Const. Co.—Holcomb to Scott City, Kans.
Kansas-Nebraska Natural Gas Co., Inc.	16	12	Cheek Const. Co.—Wakeeny to Palco, Kans.
Kansas-Nebraska Natural Gas Co., Inc.	34	12	Cheek Const. Co.—Palco to Phillipsburg, Kans.
Kansas-Nebraska Natural Gas Co., Inc.	10	12	Cheek Const. Co.—Alma to Holdredge, Neb.
Kansas-Nebraska Natural Gas Co., Inc.	26	6	Jayhawk Const. Co.—Albion to Neligh, Neb.
Kansas-Nebraska Natural Gas Co., Inc.	60	8-10-12	Jayhawk Const Co.—Grand Island to Albion, Neb.
Kansas Power & Light Co.	19	8	M. E. White—Greensburg to Lewis, Kans.
Kansas Power & Light Co.	28	12	M. E. White—Pratt to St. John, Kans. 1-16-51.
Mid-South Gas Co.	40	12	Tulsa Const. Co.—Helena to Forest City, Ark.
Missouri Central Natural Gas Co.	30	6	L. R. Young Const. Co.—Macon to Moberly, Mo.
Ohio Fuel Gas Co.	20	20	Somerville Const. Co.—New Albany to Homer, Ohio. 6-1-51.
Oklahoma Natural Gas Co.	40	16	Trojan Const. Co.—Velma to Chickasha. 5-1-51.
Oklahoma Natural Gas Co.	53	26	Trojan Const. Co.—Edmond to Depew, Okla. 3-15-51.
Phillips Petroleum Co. and Shamrock Oil & Gas Co.	310	6	Extension on 600-mile line at Phillips, Tex.-LaJunta to Denver.
Public Service Co. of Northern Illinois	25	10	Contracting & Material Co.—Matteson to Kankakee, Ill. 6-20-51.
Southeastern Michigan Gas Co.	55	12	H. L. Gentry Const.—Birmingham to Port Huron, Mich. 5-15-51.
Southern Natural Gas Co.	120	16	Associated Pipeline Contr.—Mitchell Village, Ala., to Bolingbroke, Ga.
Southern Natural Gas Co.	35	8	Latex Const. of Georgia—Opelika, Ala., to LaGrange, Ga. 7-1-51.
South Jersey Gas Co.	75	16-8	G. G. Griffis, Inc.—Transcontinental Woodbury lateral to Pleasantville and other points in South Jersey.
Tennessee Gas Trans. Co.	30	30	Houston Contracting Co.—loops in vicinity of Woodville, Tex.
Tennessee Gas Trans. Co.	42	30	Houston Contracting Co.—loops in Natchitoches to Sabine River.
Tennessee Gas Trans. Co.	47	30	Houston Contracting Co.—loops in Bastrop and Monroe, La.
Texas Illinois Natural Gas Pipe Line Co.	100	26	Midwestern Constr. Inc. (Sched. 1)—LaGloria to Refugio, Tex.
Texas Illinois Natural Gas Pipe Line Co.	110	30	H. C. Price—Hungerford to Trinity River.
Texas Illinois Natural Gas Pipe Line Co.	38	12	H. C. Price—Old Ocean field, to Chocolate Bayou field.
Texas Illinois Natural Gas Pipe Line Co.	97	26	H. C. Price—Hungerford to near Refugio.
Trunkline Gas Co.	186	26	Mahoney Contracting Co. (Section D)—Tuscola to Joppa, Ill. 7-51.
Trunkline Gas Co.	18	26	Houston Contracting Co.—Lake Arthur to Lacassine, La.
Trunkline Gas Co.	42	16-20	Houston Contracting Co. (Sect. 1)—Lake Arthur, Longville, to point north of Iowa, La. 1-1-51.
Trunkline Gas Co.	35	20	Houston Contracting Co.—Lake Arthur, La., to Lacassine, La.
Trunkline Gas Co.	35	20	Houston Contracting Co.—Longville to Lacassine, La.
United Gas Pipe Line Co.	93	6 to 16	Brown and Root; Price and McDermott Cos.—fields in Plaquemines Parish to near New Orleans.
United Gas Pipe Line Co.	54	20	Texas Louisiana Contractors—Needville to Freeport. 5-1-51.
York Gas Co. and Corning Glass Co.	30		Britton Contracting—York, Pa., and Corning, N. Y.

TABLE 10—PRINCIPAL FOREIGN CRUDE PROJECTS COMPLETED

Shell Caribbean Petroleum Co.	11	16	Bachaquero (North) to Lagunillas. 5-51.
Petroleos Mexicanos	160	11	Minatitlan to Salina Cruz, Mexico.
Shell Caribbean Petroleum Co.	11	16	Bachaquero (North) to Lagunillas. 5-51.
Shell Caribbean Petroleum Co.	18	4	Mara to Palamarejo.

TABLE 11—FOREIGN NATURAL-GAS PROJECT COMPLETED

Direccion General del Gas del Estado	62		Comodoro Rivadavia-Caleta Olivia, Argentina.

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"We cover a lot of territory with our Cardwell 'Trailerig'," reports Curtis Singleton of Corpus Christi, Texas. "In a 90-day period, we drilled eight wells to an average depth of 4,000 feet, moving our 'Trailerig' a total of 600 miles between wells."

"We keep ahead of competition with low-cost moves," reports Big Six Drilling Company of Houston. "The total paid-out expense of moving our Cardwell 'Trailerig' five miles, including tear-down and rig-up time, has been as low as $300.00."

"Our customers like fast moves and fast drilling," reports S. H. Howell of Alice, Texas. "In a 30-month period, we drilled 350,000 feet of hole to an average depth of 5,400 feet."

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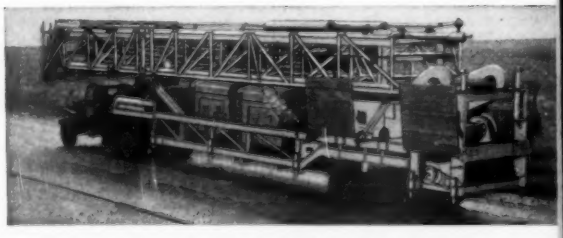
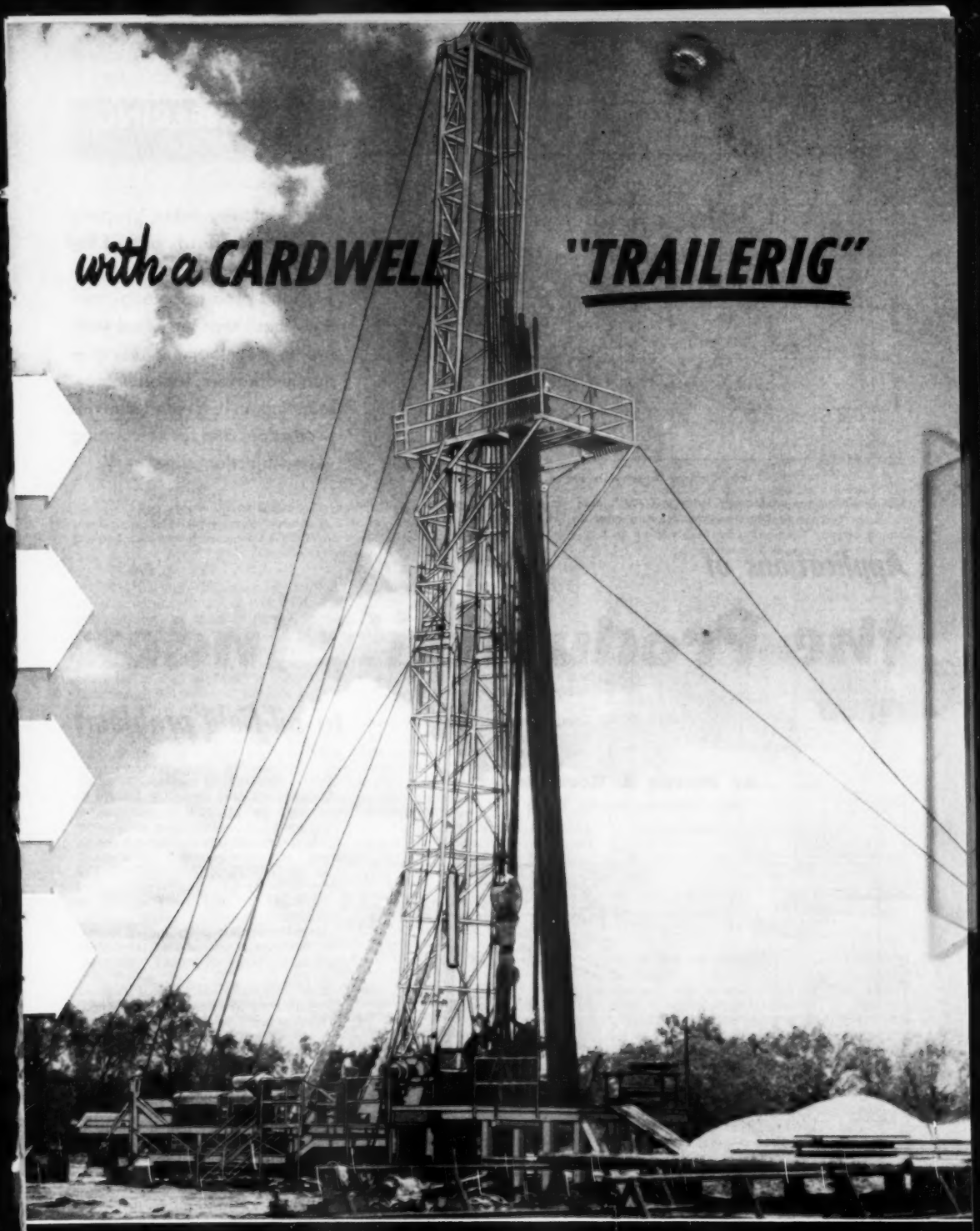


In roading position the "Trailerig" is only 8 feet wide, 13½ feet high and 59 feet long.



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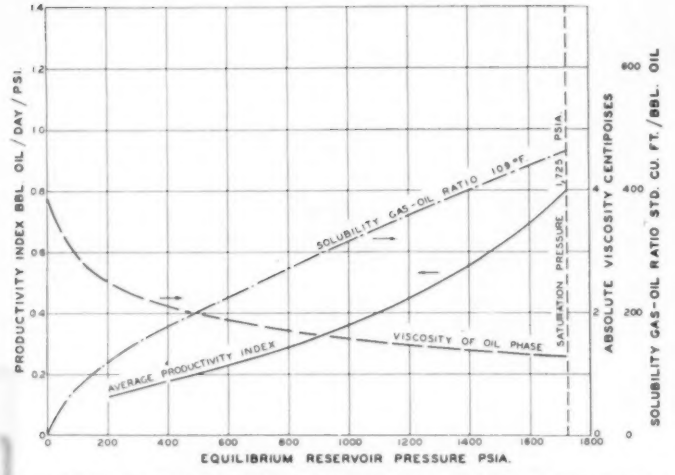

PRODUCTIVITY INDEX BBL. OIL / DAY / PSI.
ABSOLUTE VISCOSITY CENTIPOISES
SOLUBILITY GAS-OIL RATIO STD. CU. FT. / BBL. OIL
SOLUBILITY GAS-OIL RATIO 109 °F
SATURATION PRESSURE 1,725 PSIA
VISCOSITY OF OIL PHASE
AVERAGE PRODUCTIVITY INDEX
EQUILIBRIUM RESERVOIR PRESSURE PSIA.

Fig. 1—Calculated productivity index and P.V.T. data vs. equilibrium pressure for a San Andres (Permian) dolomite reservoir in West Texas.

ENGINEERING *Reference Section*

A productivity index, properly measured, affords one of the most important tools in reservoir and production engineering. These tests may find wide use in development, completion, workovers, for equipment selection, in reservoir behavior prediction, and for calculating water-injection rates.

Applications of the Productivity Index *to oil-field problems*

by Joseph A. Kornfeld
Mid-Continent District Editor

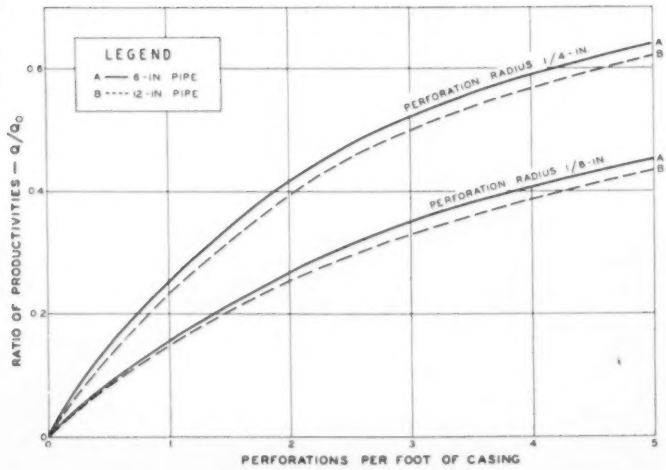


Fig. 2—Theoretical effect of perforations and size of casing on productivity index of an oil well (after Muskat, T. P. 1,528, Petr. Tech.).

THE productivity index, properly measured and correctly interpreted, may be utilized in solution of developmental, completion, and workover problems for equipment selection, reservoir-behavior prediction, and for calculation of water-intake rates in secondary recovery.

Applications may be classified as follows:

Developmental: Selection of developmental wells with major consideration as to choice of proper well spacing.

Completions: Selection of highest capacity zone in thick producing sand.

Workovers: Advisability of cleanout or workover operations; evaluation of workover operations.

Equipment selection: Proper selection of flowing, gas-lifting, or pumping equipment; relative performance of well and equipment.

Geological engineering: Recognition of discontinuities, proximity to faults.

Reservoir behavior: Use in prediction of boundaries of reservoir; prediction of abandonment of individual well; use in conversion of material-balance calculations to a time basis.

Water injection: Specific injectivity index is useful unit for comparison of water-intake capacities of wells.

Definition.—Moore[1] suggested dur-

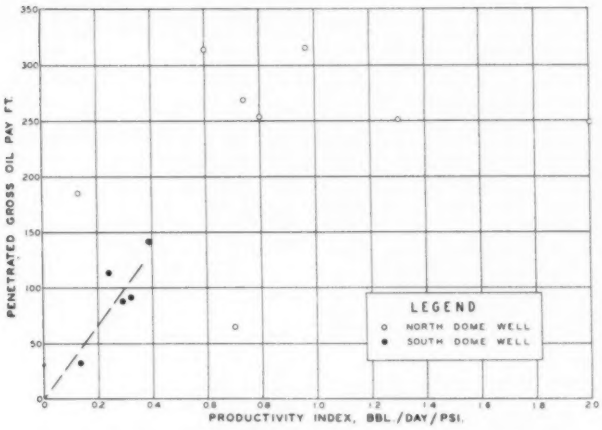


Fig. 3—Graph showing relationship of penetrated gross oil pay thickness vs. productivity index for a group of wells in Tensleep reservoir in Wyoming; with correlations between North and South Dome wells. Note average slope for South Dome performance.

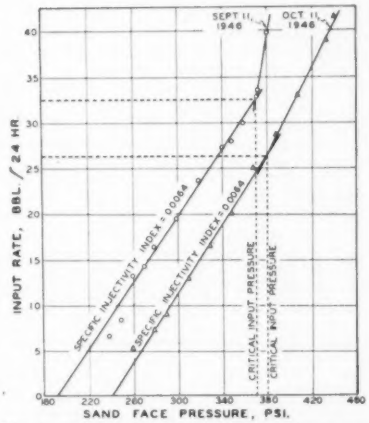


Fig. 4—Stability of specific injectivity index in reservoir completely filled with fluids. Two curves, taken 1 month apart, reveal identical values at well in McCune field, Crawford County, Kansas (Bureau of Mines).

ing 1930 the determination of the relative productivity of a well without the necessity of conducting an open-flow test. The method employed the measurement of the static bottom-hole pressure as well as the bottom-hole pressure while the well is flowed at a series of oil rates. The calculation of the ability of a well to produce is known as "the productivity index." This expression is defined as "the barrels of fluid per day produced per pound differential in pressure between static and flowing pressures." If this expression is divided by the total pay thickness, the calculation is further defined as the "specific productivity index." Briefly, the productivity index is a measure of the ability of the producing zone to yield fluid at the sand face.

In an earlier paper, the writer[2] reviewed in detail the evolution of the present formula widely used in the calculation of the productivity index. He has traced it from its roots in Darcy's law (expressed in 1856 as the quantitative theory of the flow of homogeneous fluids through porous media) to the relatively recent work of Babson[3] whose modification of Evinger and Muskat's theoretical productivity factor is generally accepted today by production engineers.

THE STEADY-STATE, RADIAL-FLOW FORMULA

The simplified form is submitted as follows:

$$P.I. = C\,\frac{\mu FVF \log_{10} r_e/r_w}{k_{RO}\, h}$$

where

C = THE MEDIA CONSTANT*

k_{RO} = relative permeability in millidarcies of the EXPOSED section

h = net effective pay in feet of EXPOSED section

μ = measured viscosity of the oil in centipoises corresponding to the temperature and pressure at the sand face (from bottom-hole sample analysis)

FVF = measured formation volume factor of the reservoir crude corresponding to the temperature and pressure at the sand face, expressed as

$$\frac{\text{bbl. oil in the reservoir}}{\text{bbl. oil at standard conditions (from bottom-hole sample analysis)}}\dagger$$

r_e = radius in feet at an external point in reservoir

r_w = radius in feet at the well bore

***A function of the configuration of the media such as particle-size distribution, mineral character of clays, cementation, and the like. †Standard conditions are considered 60° F. and 14.7 psia.**

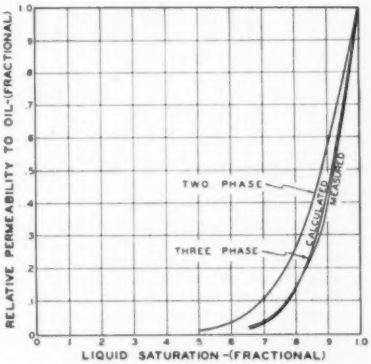
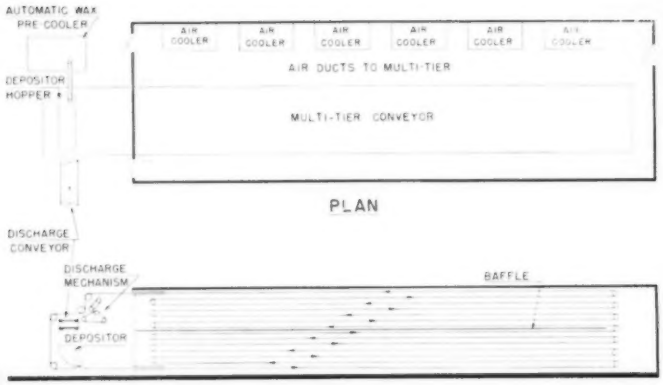


Fig. 5—Graph showing two and three-phase relative permeabilities to oil (after Branson, courtesy, A.I.M.E.).

Theoretical factors.—The factors that influence the calculation of the theoretical productivity index based on the steady-state, radial-flow formula are: specific permeability, relative permeability, the viscosity of the fluids, the formation-volume factors of the fluids, the fluid-saturation history, wetting characteristics of the media and the textural characteristics of the media.

Relative permeability to oil.—Branson[4] has pointed out that the two factors chiefly responsible for the decline in productivity of a well producing from a gas-drive reservoir are the pressure and relative permeability to oil. He explains that "since the pressure and gas saturation at each stage in the depletion of a reservoir can be calculated by the material-balance method, the radial-flow form of Darcy's law can be modified by multiplying by the proper relative

(Continued on page 315)



Arrangement diagram of cooling chamber and auxiliary equipment used in continuous molding process.

Continuous Molding Of Paraffin Wax

at Magnolia's Beaumont refinery

by

L. H. Jennings,* J. H. Beard,* and V. A. Kalichevsky*

The shortcomings of the batch molding process for manufacture of paraffin-wax cakes or slabs instigated work by engineers of Magnolia Petroleum Co. to develop improved methods. After investigating various possibilities offered by methods used outside the petroleum industry, it was decided that one type of continuous chocolate-molding machine might properly be modified to offer a solution to the wax-molding problem. Through the joint efforts of Magnolia and J. W. Greer Co., Cambridge, Mass., a continuous wax-molding system was built and put into operation at Magnolia's Beaumont refinery. This article presents the story of this achievement.

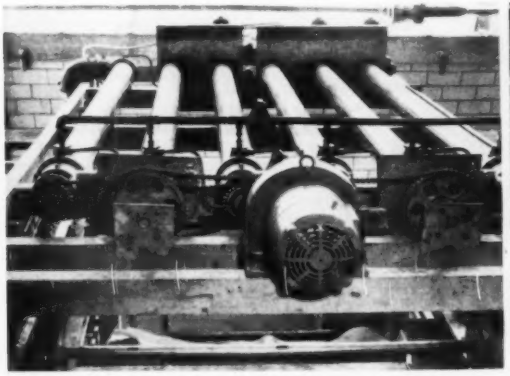
ENGINEERING *Reference Section*

THE rapid growth of the petroleum-wax industry may be visualized from the fact that the total quantity of the product which will be produced in this country in 1951 will easily pass the 1-billion-pound mark. This represents an increase of 30 or 40 per cent over the last decade. Considerably more than one-half of this figure will be represented by paraffin waxes of various melting points. Close to three-fourths of these waxes will be consumed for processing paper, while the rest will be utilized in candle and electrical insulation manufacture; in the textile, leather, cosmetic, and lumber industries, and in the formulation of polishes. These varied uses explain the necessity of supplying a widening market with more than one grade of wax.

While wax processing methods have steadily improved, wax-molding techniques have remained practically unchanged from the batch molding method first used by the industry. Conventional equipment is still represented by a modified plate and frame press with molds and cooling plates substituted for rings and filter plates.

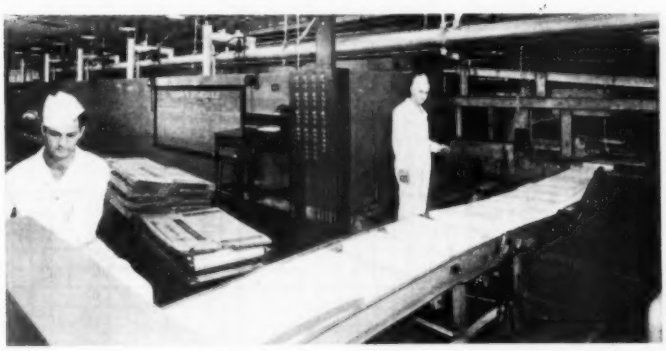
Many inherent difficulties are encountered by refineries in operating this rather primitive conventional equipment. The process is slow and expensive, requiring a great deal of manual work. The cakes are often uneven and vary in weight because of the difficulty of maintaining a continuous flow of wax into the molds during the solidification period and the presence of entrapped air. After the cakes are formed, some wax is lost in scraping off the surplus left in

*Refining division, Magnolia Petroleum Co. Portion of paper presented at meeting of Western Petroleum Refiner's Association at Wichita, July 20, 1951.



Wax from charge tanks is first run through "tempering" exchangers. In the tempering step, wax is heated or cooled as needed to maintain temperature between given limits.

Prior to entering the cooling chamber, wax is automatically measured and deposited in cooling pans. An "endless" conveyor system then moves pans through the cooling chamber.



Finished product from the continuous molding process is shown here being conveyed to packaging station. Remote-control panel for the unit may be seen near center in this view of Magnolia's installation at Beaumont.

the pan. The necessity of scraping the wax also makes the process sloppy, and the floor area required to accommodate batch equipment is comparatively large.

The schematic process flow diagram, Fig. 1, reveals the simplicity of a new continuous method for molding waxes installed at the Beaumont refinery of Magnolia Petroleum Co. Molten wax kept in insulated and steam-heated charge tanks is first pumped through automatically controlled "tempering" exchangers where its temperature is adjusted to between 140° and 160° F., depending upon the wax melting point. For best performance this temperature should be as low as possible, provided the wax does not begin to solidify before it reaches the cooling chamber. The tempering exchangers are designed to operate both as heaters or coolers in order to maintain an even temperature of the wax stream regardless of the temperature of the wax in the storage tanks.

From the tempering exchangers the liquid wax is directed to the steam jacketed "depositor hopper." This hopper is an open rectangular tank with a partially sloping bottom. The wax level in the hopper is automatically regulated by controlling the speed of the charge pump. The portion of the hopper having the flat bottom contains six pistons which act as measuring devices for the quantity of wax required to form the individual cakes. The pistons, designed for a maximum discharge of 12 lb. of wax into each pan, are easily adjustable. After the pistons are set, the weight of the wax delivered into the pans remains constant and varies less than ½ oz. between individual fillings.

The pistons discharge molten wax directly into molding pans which are 19 in. long, 11¾ in. wide, and 2 in. deep. In continuous circulation are 2,508 such pans. The dimensions are not critical although they are somewhat limited by the over-all equipment specifications for the individual installations. Considering the minimum permissible thickness of the wax cakes due to their brittleness, the pans of the above size can accommodate from 8 to 12 lb. of wax. The molding pans rest on trays which move on a chain conveyor. Each tray holds six pans corresponding to the six pistons from which the molten wax is discharged.

After the pans are filled with the wax, the trays carry them through cooling compartments where solid wax cakes are formed. Cooling is done by a stream of cold air supplied perpendicularly to the direction of tray travel. Cold air is obtained by passing the air over five dry coil evaporators connected to a 150-ton ammonia compressor.

The cooling chamber is completely enclosed and insulated to insure maximum operating economy by recirculating air within the system. For maximum output the refrigerating coils are run at full capacity and the blowers are operated at constant speed. Air temperature is maintained at 20°-30° F. Rate of cooling the wax cakes is controlled automatically by varying the speed of the conveyor. This rate depends upon the melting point of the wax to be molded; the higher the melting point of the wax, the greater the unit output.

On arriving at the end of the cooling chamber via conveyor, the trays are automatically lifted and transferred to the next higher level of the same conveyor to move in the opposite direction. This is done without disturbing the partially solidified wax in the molding pans which otherwise would result in wrinkles on its surface. Direction reversal of the conveyor may be repeated as many times as desired, contributing to the compactness of the design by substituting height for length of the cooling section. In the Magnolia installation the trays make 14 passes through the cooling section, traveling a total distance of about 800 ft. in a space 64 ft. long and 10 ft. high. The entire molding unit is driven by one 10-hp. motor through a variable speed-reduction gear. The residence time of the wax in the cooling section may be adjusted from 60 to 180 minutes by varying the speed of the main-drive gear.

Surface temperature of the wax cakes leaving the cooling chamber is controlled between 60° and 80° F., depending on the melting point of the wax. The lower the melting point of the wax, the lower the temperature at which the wax cakes are discharged.

The wax cakes are removed from the molding pans automatically. The pans which are attached to the trays are tilted until they are in the upside down position, permitting the cakes to drop from the pans. The chain conveyor then makes another turn, restoring the trays and pans to their former positions. The bottoms and sides of the empty pans are heated slightly by passing the trays over an electric heater before starting the next cycle through the system. The wax cakes dropped from the pans are picked up by a belt conveyor.

The original installation included an automatic weighing device for inspecting the wax cakes. However, this device was soon found to be superfluous because the individual cakes vary less than 0.20 per cent by weight from the average. In the conventional batch-molding process, cakes of similar sizes varied in weight by as much as 5 per cent.

The equipment, which has been installed at the Beaumont refinery, is capable of molding from 11,000 to 17,000 lb. of wax per hour, again depending upon the wax melting point. The wax cakes are exceptionally uniform in size and have a bright luster. No wax is slopped except at the very beginning of the operation while the equipment is brought up to equilibrium conditions. This slop wax is returned to a special melting tank for reprocessing.

The labor requirements per unit weight of molded wax was reduced five times as compared to the conventional batch process, with further savings in sight. The larger the volume of the wax molded, the greater the savings in manpower.

The appearance of the conventional wax-molding rooms with the wax spilled on floor and equipment is practically eliminated. The floor space required for accommodating the equipment is not over one-tenth of that normally occupied by the wax-molding presses and may be further reduced, if desired, by increasing the height of the cooling chamber.

The new continuous process is also well adapted for automatic packaging of wax cakes into paper boxes.

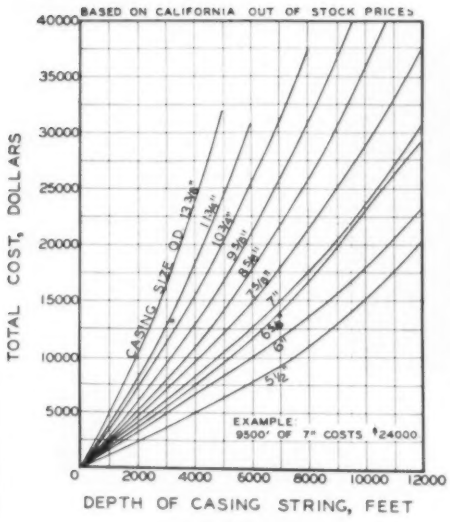


Fig. 1—Casing-string costs.

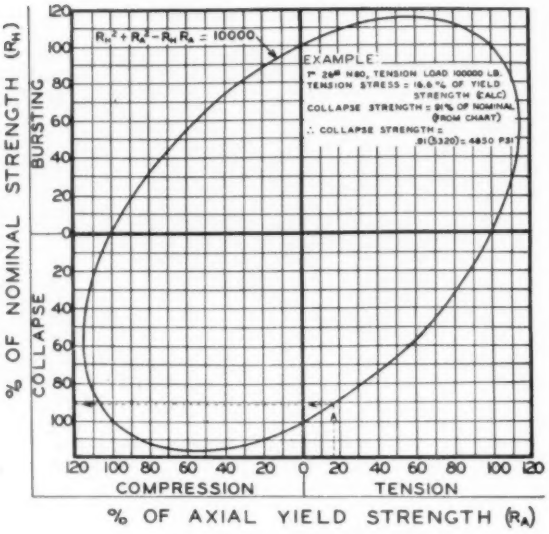


Fig. 2—Effect of biaxial stress.

CASING-STRING DESIGN

—a review of principles and practice

ENGINEERING Reference Section

Factors that affect this problem are wear, corrosion, vibration, and pounding by drill pipe; effects of gun perforating, and general abuse of tools and equipment run in the well. As depth increases the problems grow.

by J. O. Hills*

THE problem of the casing-string designer is to choose, for a given size of casing, the combination of weights, grades, and types of joints which will meet drilling and producing conditions at the least cost consistent with safety. Pipe shortages increase the importance of avoiding waste, but indiscriminate reduction of safety factors and strengths is likely to result in waste not only of money and material but of manpower and oil as well.

The most important factor controlling the cost of a string of casing is the size. Factors governing this choice are not reviewed herein, but Fig. 1 can be used to compare the costs of casing strings of various sizes.

General Considerations

Casing-string design on an engineering basis becomes of increasing importance as well depth increases, and for very deep strings the weight of the casing must be held at a minimum not only to decrease cost but to provide safety in tension. However, proper design should not be restricted to deep wells, since it will result in economy and uniform safety in wells of any depth.

Conventional assumptions are often used to simplify design procedure even when the actual conditions can be evaluated with reasonable accuracy. For example, the effects of buoyancy often are not calculated and are considered to add to the safety factor. Such procedures tend to obscure the true margins of safety and make it difficult to determine the limits to which design can be carried. Lack of full knowledge of service conditions on casing strings makes it expedient to use some simplified assumptions, but the aim of design should be to do this as little as possible. A casing string is an expensive structure protecting a large investment and the cost of engineering time required for design is relatively small.

A properly designed casing string normally will consist of a number of sections of pipe, each with a different specification. It is essential that these sections be run in the well in proper order, since running even one joint in the wrong place can have disastrous consequences. Because of the difficulty of handling and the occurrence of errors, many operators in the past were reluctant to run these "combination" or "graduated" strings. Today, however, the combination string and the necessary precautions in handling and running it are generally considered a routine part of well-drilling operations. It is still desirable to restrict the sections to a reasonable number and to avoid joint changes which make crossover joints necessary. It is also good practice to use at the top a joint or two of the heaviest weight pipe in the string. This tends to prevent starting tools in the hole which will not pass through the entire string, and also

*General Petroleum Corp. Presented at A.P.I. Division of Production meeting, Los Angeles, May 1951.

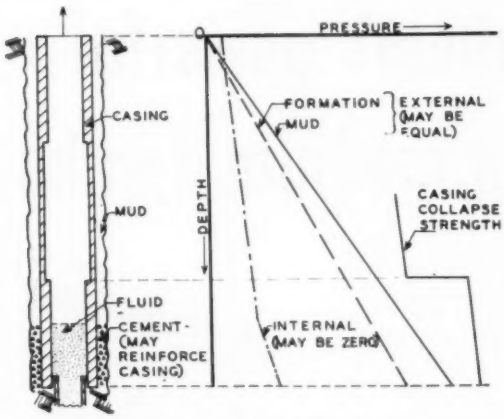


Fig. 3—Collapse analysis.

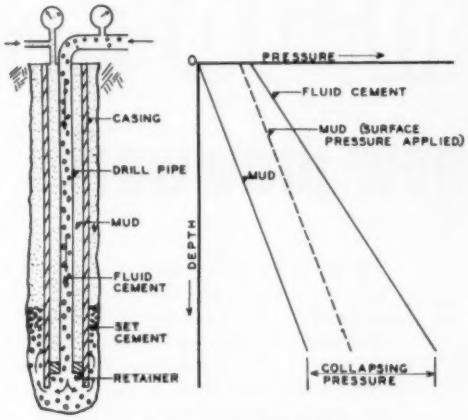


Fig. 4—Squeeze-job analysis.

provides a thicker pipe wall where the landing slips are set.

Casing Strength Information

All the necessary basic data on collapse, tension, and bursting strengths of A.P.I. casing are available in A.P.I. Bulletin 502 and 5A1. The latter bulletin, though informational only, gives strengths for A.P.I. threads on upset and specially treated ends.

All A.P.I. performance data are given in terms of minimum strengths. Collapse and tension strengths are calculated by formulas derived from test results on full-sized casing specimens. A percentage factor arrived at by statistical analysis of the test data is applied to the "average values" from the formulas to give the published minimums. Bursting strengths are derived from Barlow's formula using A.P.I. minimum yield strengths with A.P.I. minimum wall thicknesses.

In their 1940 report[1] recommending the adoption of minimum strength values by the A.P.I., Wescott, Dunlop, and Kemler expressed the hope and expectation that future test work and improvements in manufacture would result in adoption of higher minimum strength values. Unfortunately, such increases have not materialized, and the present A.P.I. minimum strengths are those adopted in 1941.

Strength data for non-A.P.I. pipe and threaded connections are obtainable from manufacturers' catalogs. Such data should be checked to determine if they are on the same basis as A.P.I. strengths, although manufacturers are generally consistent in this respect.

Biaxial stress.—In applying casing strength data, the effect of combined axial and hoop stresses should be considered. This effect is important in casing-string design chiefly because of the reduction of collapse strength due to the hanging weight of the pipe. The theoretical investigations of Holmquist and Nadai[2,3] and the experimental work of Edwards and Miller[4] indicate that the effect can be represented by the relationship shown in Fig. 2. By examination of this figure it can be seen that tension always reduces the collapse strength of casing, while moderate degrees of compression will result in an increase.

Loads on Casing Strings and Their Application in Design

The three chief types of loading which casing strings must withstand are collapse, tension, and bursting. The sources and characteristics of these loads and the determination of their magnitude are illustrated and discussed below. However, there are other considerations which may be of equal or greater importance, and which are often limiting factors in the choice of casing.

These other considerations include wear, corrosion, vibration, and pounding by drill pipe; effects of gun perforating; erosion; and general abuse by tools and equipment run in the well. They are not readily subject to the calculation, and are met by

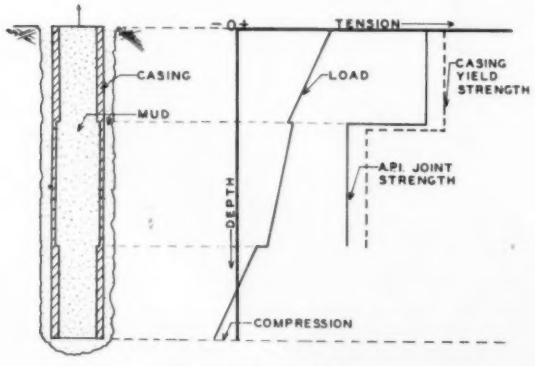


Fig. 5—Tension analysis.

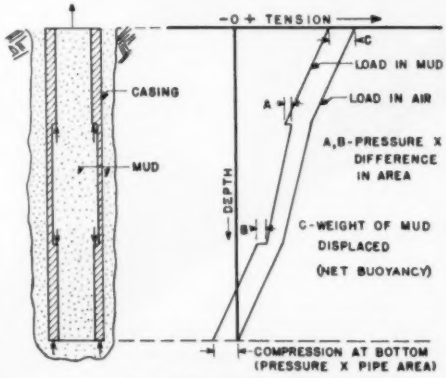


Fig. 6—Effect of buoyancy.

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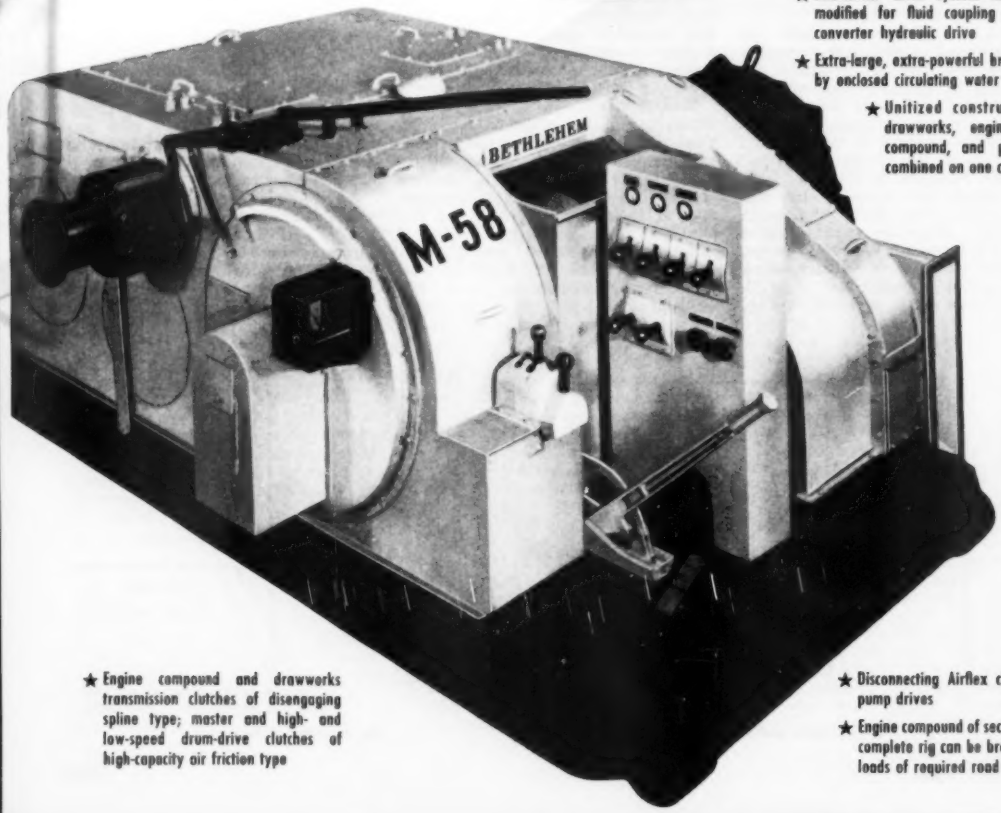

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★ Disconnecting Airflex clutch-controlled pump drives

★ Engine compound of sectionalized type; complete rig can be broken down into loads of required road width

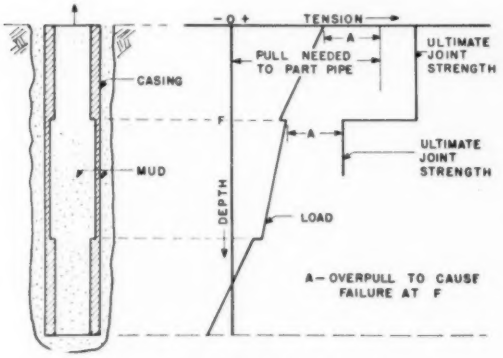


Fig. 7—Overpull to failure.

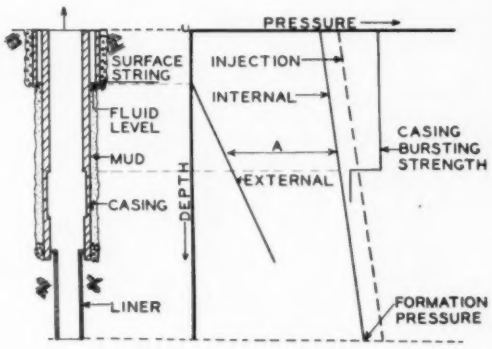


Fig. 8—Bursting analysis.

applying the lessons of experience. This usually takes the form of specifying a minimum wall thickness of pipe weight for various casing sizes and service conditions.

Tests by Oliphant and Farris[6] indicate that the stronger grades of casing resist splitting by gun perforating better than the weaker grades, and field experience seems to confirm this. Individual opinions vary considerably on these matters, but the proper approach certainly is to consider each type of case separately, specifying minimum wall thickness or strength after reviewing experience data and studying the probable importance of these considerations.

No attempt is made to design for loads caused by earth movements, since it is felt that such loads would be so large that no casing would be strong enough to withstand them. Bending and column loads on casing are not considered in design. Modern drilling practice does not permit bends in wells sharp enough to cause critical bending loads, even in directionally drilled holes. When properly handled, appreciable column loads are not imposed on casing strings.

Collapse. — This type of loading on casing strings is caused by an external pressure higher than that inside the casing and is illustrated in Fig. 3.

The most severe condition, and the one commonly used for design purposes, is represented on Fig. 3 by the mud-pressure line and no internal pressure. This corresponds to a well emptied of fluid, zero pressure on the casing head, and a full column of mud outside the casing. The casing collapse strength lines on Fig. 3 are for a string of pipe strong enough to meet this condition with a margin of safety. The strength lines slope because of the effect of biaxial stress, and are shown only for the lower sections where collapse is critical. Reduction of this maximum design pressure should be assumed only if one or more of the modifying conditions discussed below is almost a certainty.

Any internal pressure that will be maintained for the life of the well will allow a reduction of the collapse pressure to an amount indicated by the difference between the internal pressure and the mud pressure in Fig. 3. In the case of a protection string which will always be full of mud, for example, little or no collapse loading will ever be applied.

Often the mud in which the casing is run is known to be heavier than needed to balance the formation pressure. If it is certain that the mud and formation pressures will have equal-

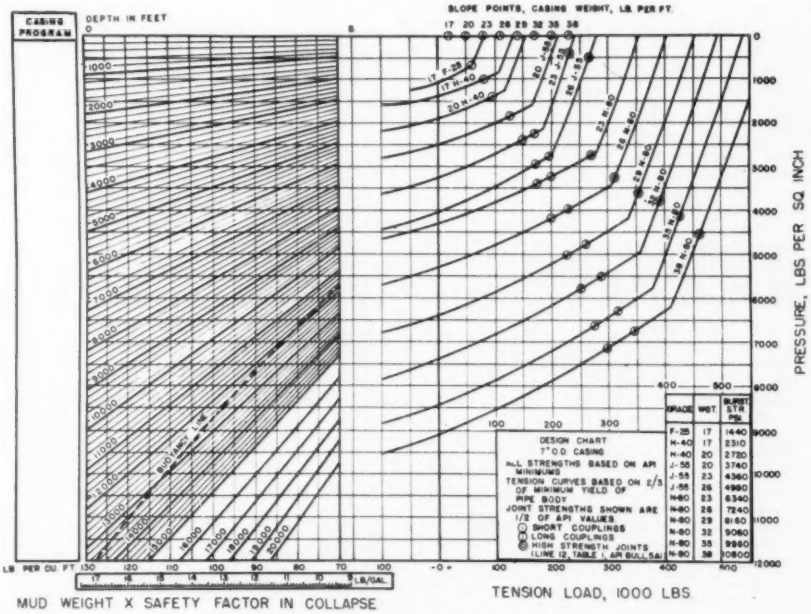


Fig. 9—Design chart.

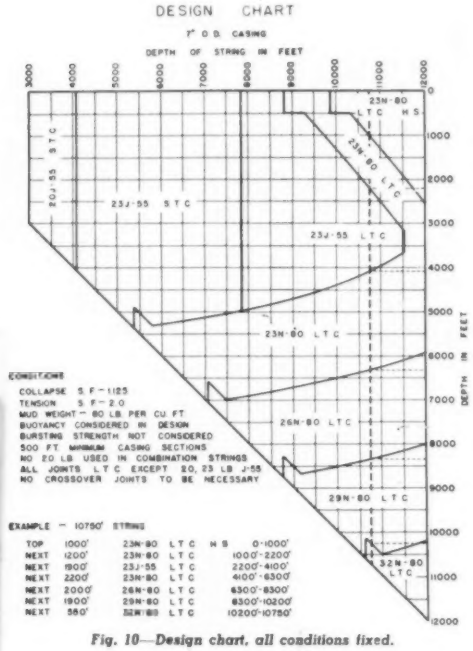

DESIGN CHART
7" O.D. CASING
DEPTH OF STRING IN FEET
DEPTH IN FEET
CONDITIONS
COLLAPSE S.F.-1.125
TENSION S.F.-2.0
MUD WEIGHT - 80 LB. PER CU. FT.
BUOYANCY CONSIDERED IN DESIGN
BURSTING STRENGTH NOT CONSIDERED
500 FT. MINIMUM CASING SECTIONS
NO 20 LB. USED IN COMBINATION STRINGS
ALL JOINTS L.T.C. EXCEPT 20, 23 LB. J-55
NO CROSSOVER JOINTS TO BE NECESSARY
EXAMPLE - 10750' STRING
TOP 1000' 23N-80 L.T.C. H.S. 0-1000'
NEXT 1200' 23N-80 L.T.C. 1000'-2200'
NEXT 1900' 23J-55 L.T.C. 2200'-4100'
NEXT 2200' 23N-80 L.T.C. 4100'-6300'
NEXT 2000' 26N-80 L.T.C. 6300'-8300'
NEXT 1900' 29N-80 L.T.C. 8300'-10200'
NEXT 550' 32N-80 L.T.C. 10200'-10750'

Fig. 10—Design chart, all conditions fixed.

ized by the time the internal pressure is removed, the formation pressure can be used as the external design pressure.

Cement placed around the bottom will give some protection against collapse and may justify a slightly reduced collapse safety factor at bottom. Also favoring a lower safey factor at bottom is the fact that the internal pressure is more likely to be maintained there than further up the string.

One fairly common well operation which can result in abnormally high collapse pressure is a squeeze job as illustrated in Fig. 4. Because fluid cement in the drill pipe usually is heavier than mud in the casing, collapsing pressure imposed on the casing above the retainer may be considerably greater than surface pressure. As shown by the dotted pressure line, the collapse load can be reduced by surface pressure applied to the casing, but in wells where squeeze jobs are likely to occur, stronger than normal pipe at appropriate points should be considered.

It is evident that for design purposes a maximum collapse loading can be predicted, and it is not a fatigue or impact loading.

Tension.—The weight of pipe when hanging free just before cementing is the most readily calculable tension condition, and is the loading condition commonly used for design purposes. It is illustrated in Fig. 5 for a string of pipe with a light weight center section. Diagramed at the right of the figure are A.P.I. joint strengths capable of supporting the string with minimum safety factors of approximately 2.0 at the critical points. The location of the casing yield strength as shown is typical of standard A.P.I. joints, for which the yield strength of the pipe body is greater than the A.P.I. joint strength. For upset or other high-strength joints the reverse is often true, and body yield strength rather than the strength of the joint may limit the design.

When the casing string is being run in the hole it will be subjected to acceleration loading by setting of slips and application of hoist brakes. If the string should stick it may be subjected to high tension loads in an attempt to pull it free.

Buoyancy.—Fig. 6 compares the tension loading conditions of pipe hanging in air and in mud. The effect of buoyancy on the pipe strings hanging in fluid has been analyzed by Klinkenberg,[6] Hawkins and Lamont,[7] Holmquist,[8] and Payne.[9] These analyses show that the effect is as shown by the "Load in Mud" curve on Fig. 6, and that the compression loading due to fluid pressure acting on the bottom does not tend to cause buckling. The load increase from the bottom of the hole upward is at the same rate as if the pipe were hanging in air. Since the pipe weight (and therefore the cross-sectional area) changes at "A" and "B," the mud pressure on the differential area result in an abrupt change in load at these points. This load change is equal to the mud pres-

(Continued on page 334)

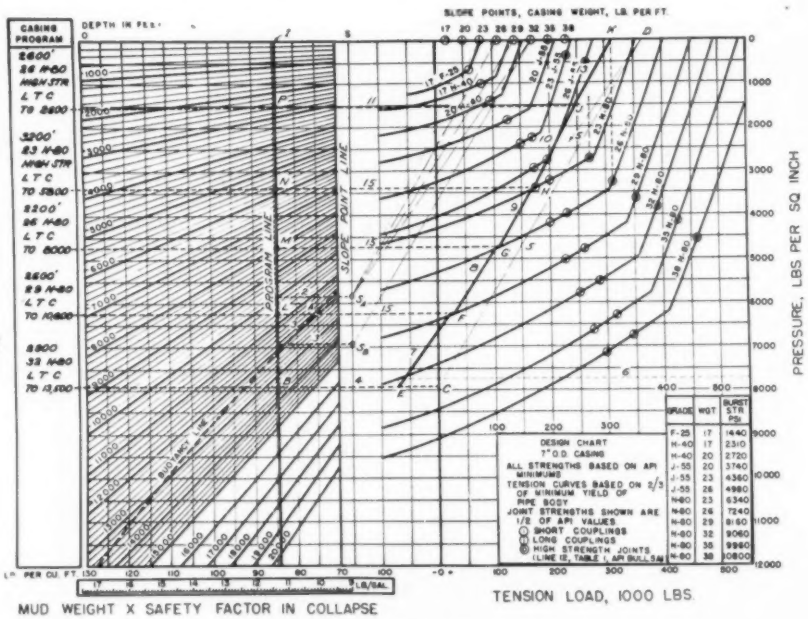
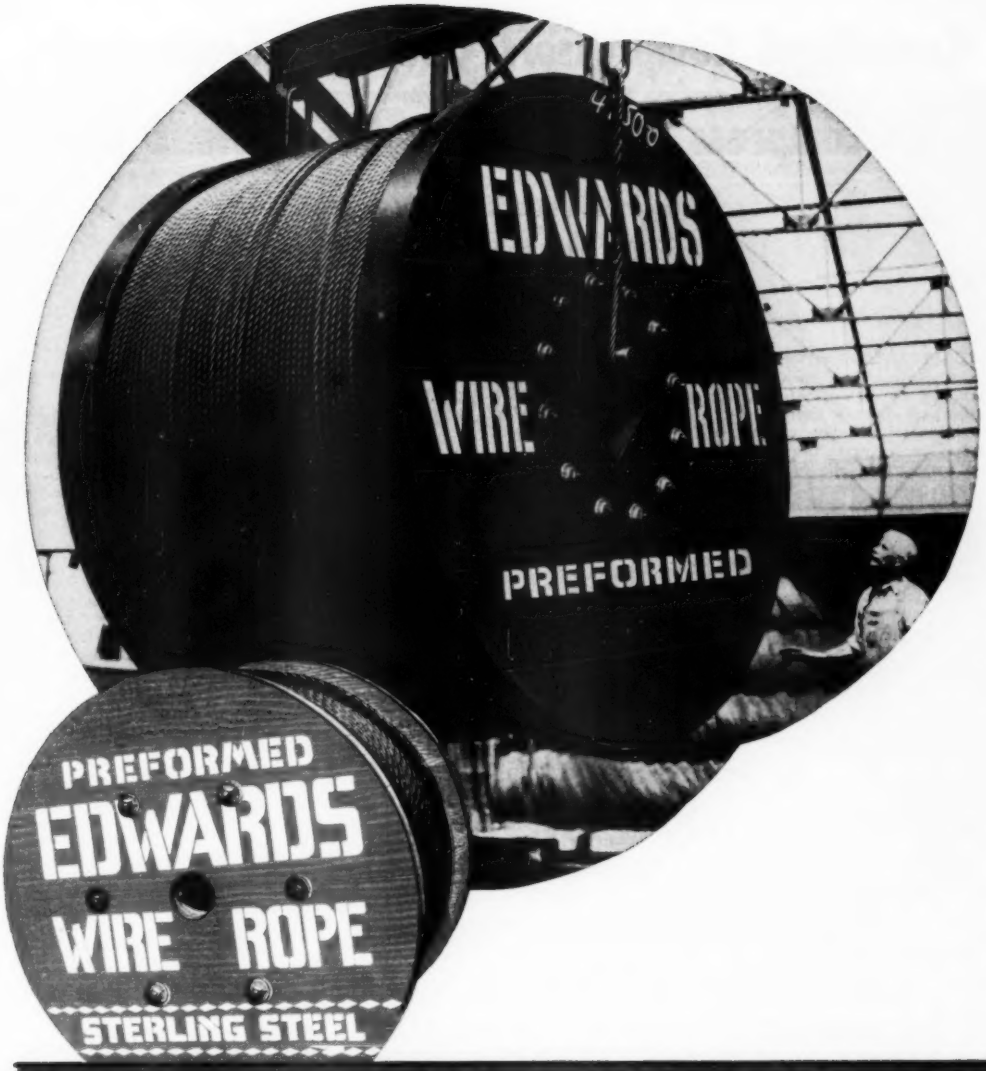

CASING PROGRAM
DEPTH IN FEET
SLOPE POINTS, CASING WEIGHT, LB. PER FT.
SLOPE POINT LINE
PROGRAM LINE
DESIGN CHART
7" O.D. CASING
ALL STRENGTHS BASED ON API MINIMUMS
TENSION CURVES BASED ON 2/3 OF MINIMUM YIELD OF PIPE BODY
JOINT STRENGTHS SHOWN ARE 1/2 OF API VALUES
SHORT COUPLINGS
LONG COUPLINGS
HIGH STRENGTH JOINTS (LINE 12, TABLE 1, API BULL 5A)
GRADE
WGT
BURST STR. PSI
MUD WEIGHT X SAFETY FACTOR IN COLLAPSE
TENSION LOAD, 1000 LBS.
PRESSURE, LBS PER SQ INCH

Fig. 11—Design chart.



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Centrifugal Compressors Operating Economically To Compress Low-Pressure Casing-Head Gas

Seeligson installation is a pioneer application in connection with a process-plant operation

by D. T. McDonald*

ENGINEERING Reference Section

STEAM turbine-driven centrifugal compressors have been installed at Seeligson Operators' Plant to compress low-pressure casing-head gas, discharging into the suction of a battery of reciprocating compressors. The installation has been operating slightly over 2 years. Operating characteristics of the individual centrifugals and of the combination centrifugal-reciprocating station are discussed and the mechanical and cost history of the installation is given.

When the plant engineering committee first met to design the Seeligson Operators Plant, located at Premont, Tex., the first question posed was "How much casing-head gas shall we design for?" The field was known to have many oil-bearing formations and the development program was still going ahead at a rapid pace. Reservoir engineers predicted that the volume would probably vary from 50 to 70 million cubic feet per calendar day, depending upon development program, conservation practices, market conditions, and the natural behavior of the reservoirs.

*Natural-gas department, Magnolia Petroleum Co. Presented before N.G.A.A. meeting at Tulsa, 1951.

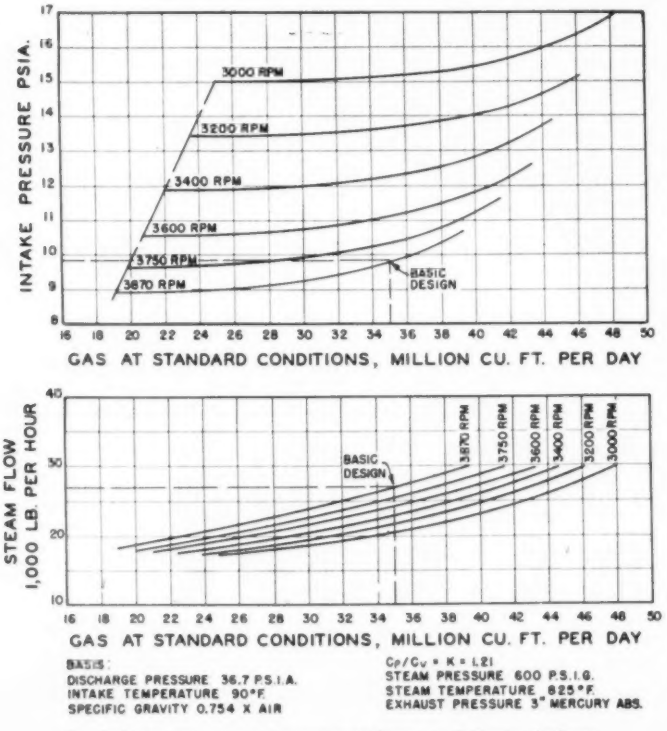


Fig. 1—Performance curves for each turbo-blower at 36.7 psia. discharge.

Four-stage compression.—It had already been decided to operate the plant with atmospheric field separation and about 10-in. Hg vacuum at the compressor intake. Discharge pressure was to be about 1,000 psig. to admit the residue gas into a transmission pipe line. The pressure range dictated four-stage compression. Overall economics dictated large compressor units. To the engineers it seemed a natural application for centrifugal compressors on the low stage where large volumes of gas would have to be handled at subatmospheric suction pressure.

It was decided to install 1,600 b.hp. Clark reciprocating compressors for the three high stages and two Ingersoll-Rand 36,500-cu. ft. per minute, 3,470-b.hp. steam turbine-driven centrifugal compressors for the low intake stage. It is interesting to note that on the full 70-million-cubic-foot design basis the two centrifugals replaced fourteen 38-in. reciprocating cylinders, the lead lines to which would have been of 24-in. diameter.

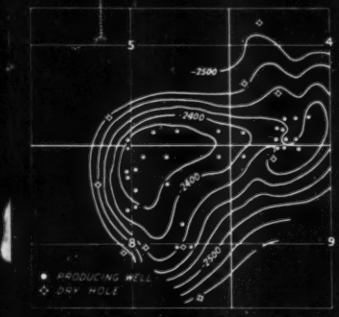
Equipment Installation

Centrifugals.—The turbine and compressors are direct connected and mounted on a rigid steel base approximately 9 ft. 6 in. wide and 30 ft. long. The turbines are rated to use 600-psig., 825° F. steam at the throttle to full condensation at 27-in. Hg vacuum. The compressors are rated to handle 36,500 cu. ft. per minute from 10-in. Hg vacuum to 36.6-psia. discharge or a compression ratio of about 3.75.

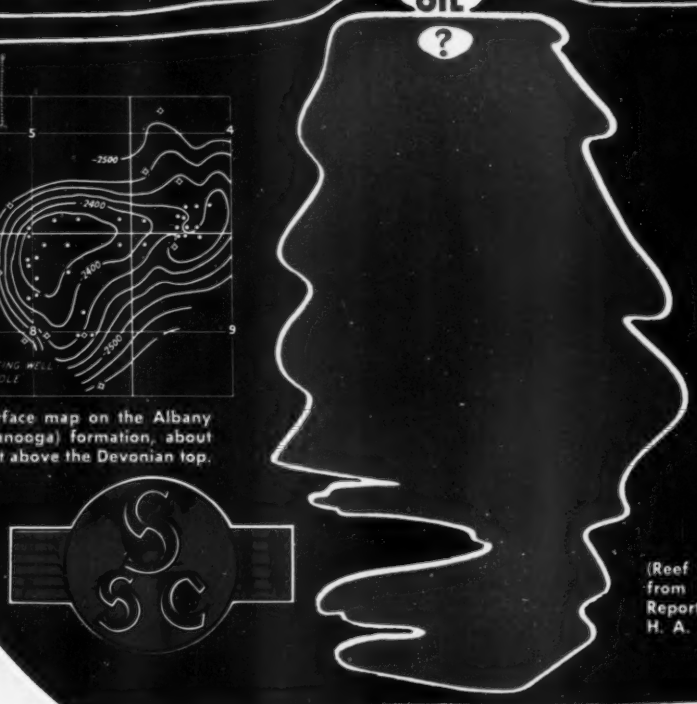
Since the centrifugals pump directly into the suction of a battery of three-stage reciprocating compressors which have five steps of unloading, the compressors are also rated to handle about 15 per cent greater gas throughput when pumping from about 4-in. Hg vacuum to 52.8 psia. which is a compression ratio of about 4.12.

All gas enters the plant through a master inlet scrubber. Each centrifugal takes suction through a 36-in. intake line and discharges through a 30-in. line. Gas from the discharge scrubber feeds through a header from

Are you looking for Reefs?



Subsurface map on the Albany (Chattanooga) formation, about 50 feet above the Devonian top.



SSC's 1939 seismic map contoured on a reflecting horizon approximating the Devonian top.

(Reef outline and description adapted from Illinois State Geological Survey Report of Investigations No. 145 by H. A. Lowenstam.)

SANDOVAL REEF (Illinois)

MARION COUNTY

The Sandoval reef, approximately cuboidal in horizontal section, is considered to be located near the southern edge of the Silurian reef archipelago. It differs from the Marine reef in its smaller areal extent (about one square mile), and in its greater vertical thickness (about 1000 feet)—one of the tallest reefs found thus far in the area. Most of the oil accumulation associated with the Sandoval reef occurs in draped Mississippian and Devonian horizons, although some production may occur in the upper reef zone.

The configuration of the seismic contours on the Sandoval structure was somewhat disconcerting to the interpreters in 1939 because of the steep dips, the irregular outline, and non-alignment with known structural trends. The recently established association of the structure with a tall reef mass now explains these irregularities.

Thus, the necessity for detailed seismic surveys and a careful analysis of the seismic data, in the light of the current geological knowledge is emphasized. This reef is an example of SSC's recognition and use of this approach.

Seismograph Service Corporation

TULSA, OKLAHOMA, U.S.A.

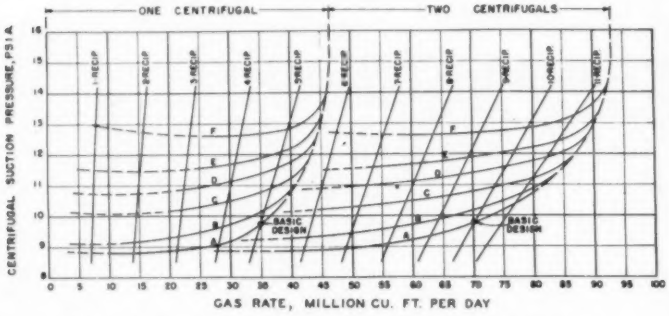


Fig. 2—Performance curves for centrifugals supercharging reciprocators.

which the engine compressors take suction.

Controls.—For control of the overall casing-head gas-compressor station a pressure controller operating the steam governors causes the centrifugals to discharge at a constant pressure. As the field volume to the plant changes, the suction pressure to the centrifugal changes in direct proportion. A second pressure controller actuated from the plant intake scrubber over-rides the engine governors and regulates the speed of the reciprocating compressors, within their speed range, to maintain an approximately constant plant intake pressure. In addition to the operating control just described, units may be put on or taken off the line or the pressure ranges can be changed by unloading steps. With these combinations an extremely wide range of flexibility has been designed into the combination centrifugal compressor station.

Operating characteristics.—The centrifugal compressor is analogous in operating characteristics to the familiar liquid centrifugal pump. It is different only in that a compressible fluid is being handled. Fig. 1 shows a typical set of performance curves for either of the centrifugal units when operating at a constant discharge pressure of 36.7 psia. The upper group of curves shows the effect of varying suction pressure and speed upon the gas handling capacity of the unit. It should be noted that (1) the increase of suction pressure calls for a reduction in speed when the unit is handling the same volume of gas and (2) the characteristic curves are relatively flat over a wide volume range. This means that with only a small alteration in speed or suction pressure, the capacity of the unit can be varied as much as 50 per cent with ease. The lower family of curves indicates the steam consumption of the turbine as a function of speed and gas throughput capacity. The steam consumption is a direct function of the horsepower consumed in compressing the gas. For any given volume as the suction pressure comes up, the turbine slows down and consumes less steam.

Unloading steps.—As previously mentioned, the reciprocating compressors are equipped with five steps of unloading in addition to the basic design condition. The centrifugals were rated to synchronize in both pressure and volume conditions with the unloading steps on the fixed displacement reciprocating compressors. Fig. 2 shows the limitation of the gas-handling capacity of the combination compressor station as a function of the number of reciprocating units, the number of centrifugal units, the unloading steps, and the intake pressure on the plant.

The curves labeled A through F represent the minimum intake pressures to handle the corresponding volume when the centrifugals are discharging at the suction pressure required for the reciprocating unloading step. All of the curves are for the full rated speed of 3,870 r.p.m. on the centrifugals. By altering the centrifugal suction pressure, discharge pressure, or speed of the unit, almost an infinite combination of flowing gas conditions can be handled in line with the characteristics performance shown in Fig. 1.

It is a well-known fact that casing-head-gas flow to a gasoline plant is anything but constant either as to volume or pressure. The plant has to take what comes to it with little or no control over the source of supply.

A careful study of Figs. 1 and 2 by anyone experienced and conversant with the characteristic operation of reciprocating compressors will show the wide range of flexibility allowed at the Seeligson installation through the use of the centrifugals and the unloading steps on the reciprocators.

Mechanical history.—Table 1 summarizes the operating time for the period April 19, 1949, through March 1951, for each of the units. The down time for the mechanical repairs is shown to be only 56 hours out of a total 22,164 unit operating hours. It should be noted that the period of time covered in the table is after seal-gland trouble encountered soon after initial startup. At the time of the seal-gland trouble, the plant was operating under a light load and one unit had more than enough capacity to carry the plant. Also shown in Table

(Continued on page 347)

TABLE 1—OPERATING TIME AND OIL CONSUMPTION FOR SEELIGSON CENTRIFUGALS*

	Unit No. 1	Unit No. 2	Total
A. Operating Time			
1. Time on line, hour	8,499	13,665	22,164
2. Horsepower-hours, 1,000's,	29,490	47,420	76,910
3. Time off line, hours			
a. Light gas load	8,269	3,112	11,381
b. Mechanical repairs	32	24	56
B. Oil Consumption			
1. Consumption, gallons	349	678	1,027
2. Consumption, gallons per 1,000 horsepower-hour	0.012	0.014	0.013

*For period April 1949 through March 1951. Does not include period immediately after startup when seal-gland leak necessitated factory rebalance of one impeller.

TABLE TWO—ANNUAL OPERATING EXPENSE FOR SEELIGSON CENTRIFUGAL COMPRESSORS

	Dollars per horsepower per year
A. Direct operating expense	
1. Operating labor	$ 0.0434
2. Supplies	0.0325
3. Hauling	0.0012
4. Maintenance and repair	0.4480
5 Miscellaneous	0.0346
Subtotal	0.5597
B. Indirect operating expense	
1. Steam power (including fuel and depreciation)	7.1043
2. Electric power all auxiliaries	2.1024
3. Water supply, treating, disposal	1.8700
Subtotal	11.0767
C. Fixed charges at 6 per cent	5.2824
D. Total annual cost	$16.9188

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Statistical Analysis Aids QUALITY CONTROL

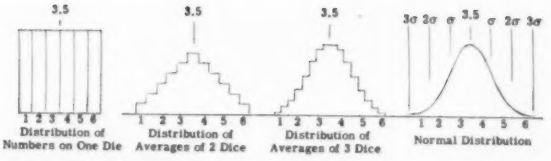
3.5
3.5
3.5
3σ 2σ σ 3.5 σ 2σ 3σ
1 2 3 4 5 6
Distribution of Numbers on One Die
Distribution of Averages of 2 Dice
Distribution of Averages of 3 Dice
Normal Distribution

Fig. 1—The frequency distribution of the averages of small subgroups.

by P. C. White and W. B. Traver

ENGINEERING *Reference Section*

Statistical analysis is an essential tool in the interpretation of observed data from process control and research experiments. Knowledge of the probability that trends or differences in current data are due to the inherent variability of the system or to new causes is insurance against acting on nonsignificant observations, and is a guide in refining measuring techniques so that observations become truly meaningful. Applications of control charts have been made to the control of motor-oil can-filling weights and to the shutdown frequency and run lengths of a battery of refinery units.

The authors are associated with research department, Whiting, Ind., and the engineering research department, Chicago, Standard Oil Co. (Ind.), respectively.

THE field of quality control is frequently understood to involve only the performance of the analytical and inspection tests that must be made on process streams and products before shipment, and that also play such an important part in the evaluation of research experiments. Vast sums are spent on this testing, and great pains are taken to use the best instruments available for such work. It is the usual practice to interpret the results—the compliance or deviation from the specification, the evidence of improvement in the product or yield from experiments—with only minor regard to the inherent variability of the tests. Interpretation, or "mental analysis," of the data is just as important as the chemical analysis; it also deserves application of the best techniques available.

Statistical analysis is the art of making common sense out of figures. Like any other mathematical technique, statistical methods cannot reveal anything not already implicit in the data. The essential contribution of statistical analysis to improved interpretation of data is to provide a numerical measure of the variability of the data. Thus a formal and objective distinction may be made between different sources of variation, so that reliance need not be placed solely on intuition and experience. On the basis of this numerical measure of variability, the probability that variations or trends may be ascribed to chance or to cause may be calculated. One may reason from a particular set of observed data to a general conclusion, knowing what the probability is that his conclusions are correct.

Control Charts

In statistical quality-control work using control charts, periodic observations are made of some property in a continuous process. The aim is generally to decide, to a predetermined degree of certainty, whether variations in the data have a casual basis and require action or have only a chance basis and require no action.

The control chart is a technique for applying a running test of significance to the variations, from time to time, in a continuous process. This test of significance consists of comparing the variations in the actual data with an ideal model to prove or disprove the hypothesis that the observed variations have a causal basis. The cost commonly used model is the "normal" frequency distribution. One characteristic of this distribution of fundamental importance in control-chart work is that, even though the quality characteristic being controlled may not be distributed "normally," as is frequently the case, averages of several successive measurements tend to be so distributed.

For example, on dice there are the numbers from one through six, each occurring once, each equally likely to appear. A series of throws of one die will therefore give rise to a square frequency distribution with an average of 3.5 (Fig. 1).

In the game of craps, the totals of two dice (twice the average) are of importance. These totals or points, as is well known, do not occur with equal frequency but appears with the relative frequencies shown in Fig. 1. The average, however, is still 3.5. The distribution of totals (or averages) of three dice is also shown. While the normal distribution is drastically different from the distribution of individual numbers on the dice, it is clear from the illustration that the normal distribution is a reasonably good approximation to the distribution of averages. This approximation becomes progressively better as the number of items averaged in a group is increased. For this reason, it is customary to plot averages of groups of values on control charts whenever possible, rather than individual points.

Standard procedure on refining units is to record periodic observation of a process variable on the daily run sheets. Control is exercised merely by glancing up and down the columns and noting trends, or data points outside the target range. Most technical men would agree that the mechanical step of simply graphing the data points would be an aid in spotting trends and erratic points. With a simple graph, however, one must rely on judgment to help in evaluating trends or erratic points. With control, based on normally distributed group averages, judgment is guided by the "control limits."

Statistical measure of the width or spread of the normal distribution curve is the standard deviation σ—the distance of the point of inflection of the bell-shaped curve from the mean, in the units of the variable. The estimate of σ, based on a finite sample, is always designated by the letter "s."

Control limits are placed at some multiple, usually 2 or 3, of s from the center or average line (Fig. 1), in order to include a predetermined percentage of the total distribution. If the limits are set to include 99 per cent of the total distribution, then a

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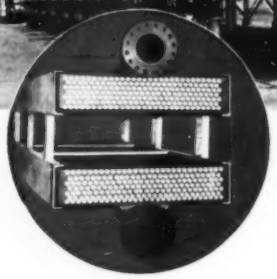

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point falling outside the limits indicates either that a 100-to-1 chance event has occurred or that a change in the complex of causes giving rise to the distribution has occurred. In this manner, control charts serve as a guide in judging whether or not to act on the variations of the process or whether a search for a cause of variation is likely to be successful. The functions and utility of statistical control charts are illustrated by the following examples:

Uniform filling weights.—Fig. 2 illustrates the use of the control chart for variables in maintaining the average value of the measured variable at a prescribed level.

In this example, 1-qt. cans are filled with motor oil in a multiple-spout filling machine. The quantity of oil delivered is determined by the travel of a piston in a cylinder for each spout. The pistons are rigidly connected to each other, and adjustment of the filling volume is made by turning a single hand wheel on the machine.

A preliminary experiment was made to determine the inherent variability or standard deviation of the machine. For single cans, this was about 0.5 per cent, independent of the grade of oil.

On the basis of this standard deviation, the illustrated chart was constructed with the center line drawn at the gross weight of five cans filled to 102 per cent of 1 qt. and with the action limits set at 2s, so that the odds were about 20 to 1 against getting a point outside these limits.

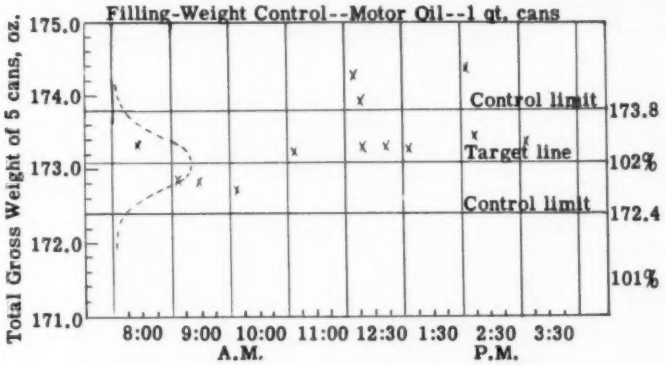
The limits 2s were chosen, rather than 3s (300-to-1 odds), because in this particular operation it was feasible to allow the greater probability of making an unnecessary adjustment in order to reduce the chance of not making an adjustment when one was really necessary. In this case, the economic penalty is small for the first kind of error and greater for the second kind of error. This economic balance between the two kinds of error is always the basis for setting action limits.

The chart then indicates, with each point plotted, whether the deviation of the sample from the target really indicates that the machine is in need of adjustment or not. That is, variation within the action limits will occur when the machine is set on the target, whereas a point outside the action limits indicates with reasonable certainty that the machine is off the target. The operator weighs all five cans of his sample simultaneously and without calculations, since the chart is calibrated in terms of gross weight of sample. This chart has justified its existence in the following ways:

1. It always permits the operator to make the best decision as to whether the weight of the sample indicates his machine requires adjustment or not; it thus reduces control effort.

2. It furnishes an excellent record of the degree of control obtained on each day's production, as it shows both the trouble experienced and the corrective action taken.

3. By improving the uniformity of filling weight to the maximum and measuring the remaining variability, it makes it possible to consider reducing the target fill with a corresponding saving of oil while at the same time insuring that underfilled cans are at a satisfactory minimum.



Time	Total Wt. 5 cans	
8:00	173.6	
9:00	172.8	172.8
10:00	172.8	
11:00	173.2	
12:30	173.3	173.3
1:30	173.3	
2:30	173.5	
3:30	173.4	

Adjustment Checks Total Wt. - 5 cans			
1	2	3	4
174.3	173.9		
174.9			

Fig. 2—Statistical control chart.

OPERATOR'S INSTRUCTIONS

1. Record total gross weight of five cans at times indicated.
2. Plot point on chart.
3. If the point falls outside the control limits, adjust filler machine and weigh a new sample of five cans. If the new sample weight falls outside the control limits, make another adjustment and take another check. Repeat this until a sample weight falls between the control limits.
4. As soon as a point falls between the control limits, do not adjust filler machine. Make next weight check 1 hour later.

Thermal cracking run lengths.—It is often advantageous to apply statistical techniques in studying routine maintenance operations. Figs. 3 and 4 record shutdown frequency and average run length of a large group of thermal cracking units. Some of the causes of shutdowns are as follows:

1. Mechanical failure—pump defects, for example.

2. Clogging of lines and soaking drums with coke at any of the number of different locations.

3. Overheating and failure of furnace tubes due to coke formation, water in feed, combustion details in the furnace, etc.

4. Voluntary decision—in line with scheduled refinery operations or for inspection and repairs.

One purpose of statistical analysis of performance data is to aid in determining the true fundamental causes of these shutdowns, of which some of the above causes may be merely effects.

The control chart for shutdown frequency (Fig. 3) shows the number of cracking units that were shut down in successive calendar weeks. As long as the basic complex of shutdown causes is unaltered, a constant average number of shutdowns per week will occur, with individual weeks having greater or fewer shutdowns with a frequency that may be calculated.

If a new cause of shutdowns is added to the complex, a large number of shutdowns will occur. It is extremely unlikely that such an increase would have occurred as a result of the original cause complex.

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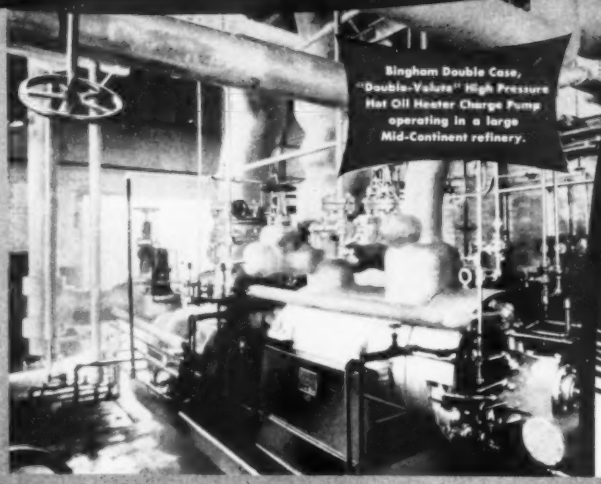

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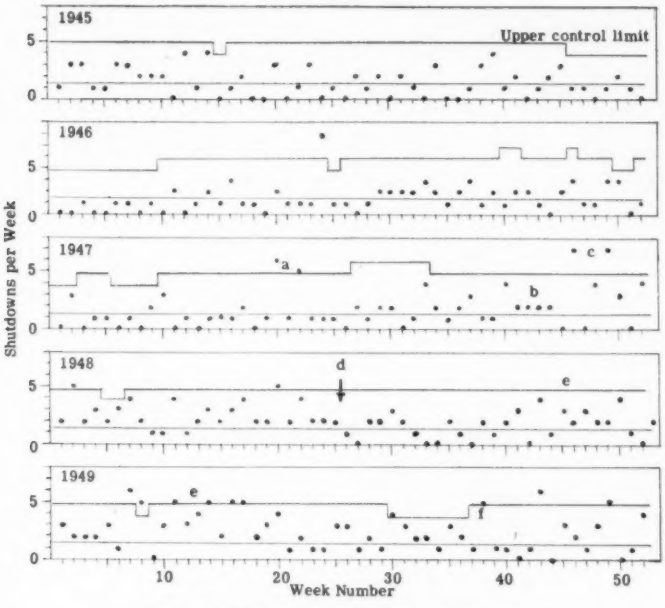

Fig. 3—Statistical control chart—shutdown frequency.

The control limit on this chart is the dividing line between the number of shutdowns that may occur normally in a week and the greater number of shutdowns that would indicate a new cause has arisen. The control limit is variable because the number of units on stream and, therefore, opportunity for shutdown, varies.

The control chart for run lengths (Fig. 4) shows the average run length of those runs that ended during each month. The control limits are variable because they vary inversely as the square root of the number of runs ending during each month.

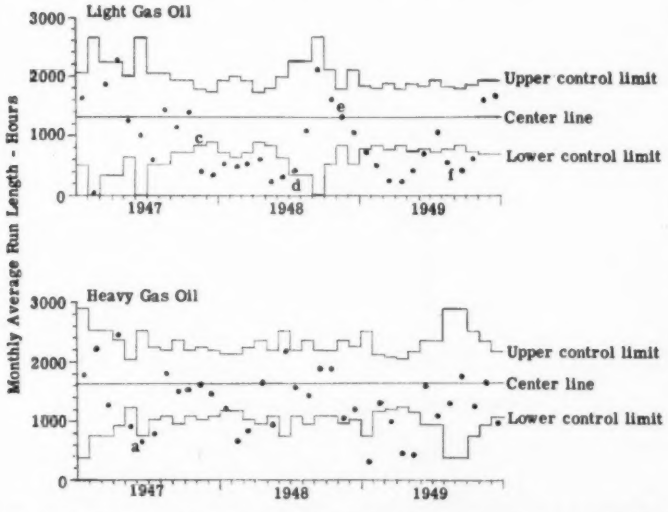

Fig. 4—Statistical control charts—run length. Each point represents the average length of those runs ending during the month.

These statistical control charts aid in the analysis of run-length data by establishing a normal or "standard" run length for both light and heavy-gas-oil operation. The control limits furnish a rational and simple means of judging whether current run lengths have significantly departed from the normal. By referring to the control charts for run lengths and shutdowns, one may judge the effectiveness of the charts in making such a distinction.

In May 1947(a),* a number of heavy-gas-oil runs ended because of overheated tubes caused by a slug of water having entered the heavy-gas-oil stream. The average heavy-gas-oil run length for May 1947 was well below the lower control limit. For the two following months heavy-gas-oil run lengths remained abnormally low. This effect can very likely be ascribed to the overheating in May having shortened the life of some furnace tubes which were not sufficiently damaged in May to have required replacement.

At the beginning of November 1947(c), a chemical which was mixed with the feed to reduce corrosion was removed from the light-gas-oil stream. This was reflected immediately in the shortened run lengths on the light-gas-oil chart. In June 1948(d), the chemical was replaced and in July the control chart indicated that light-gas-oil run lengths were back in statistical control.

Similarly the light-gas-oil run lengths shortened progressively beginning in October 1948(e), with the introduction of catalytically cracked stock into the feed. They reached a low point in March and April of 1949, when an effort was made to blend this stock more uniformly with the other feed stocks entering the light-gas-oil stream, until in July a state of statistical control was again achieved.

Again in August(f), light-gas-oil run lengths dropped out of control; the cause was found to be that overloading of some of the furnaces in light-gas-oil operation had caused a greater-than-normal number of shutdowns due to hot furnace tubes. This condition was then remedied by reducing the throughput of these furnaces.

These charts thus serve as sensitive indicators of trouble that evidence themselves in terms of shorter run lengths and more frequent shutdowns. In addition, the knowledge, within limits, of the number of shutdowns to be anticipated aids in scheduling labor requirements.

These examples illustrate how statistical techniques aid in drawing valid conclusions from repetitive data. Wherever measurements are made or

*Parenthetical letters refer to corresponding letters on Figs. 3 and 4.

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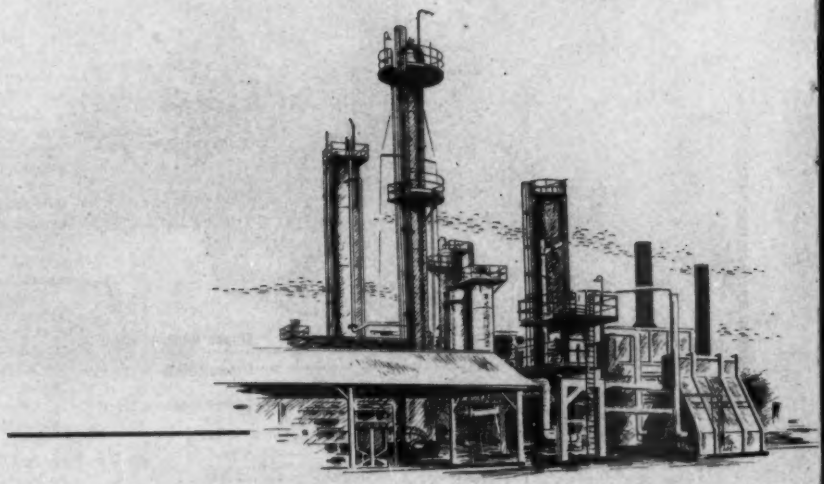

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events or items are counted and have to be judged against a standard or against past performance, statistical control charts are a simply applied and sensitive instrument for drawing consistently valid conclusions.

Design of Experiments

In the classical method of experimental research, it has been the general practice to study the effect of changing conditions by varying one factor at a time in order to determine the optimum combination of conditions from the standpoint of yield or product quality. Experimenters have often been warned against changing two factors simultaneously, since it would then be impossible to determine which factor change had been responsible for the effect observed. However, it is now recognized that if an experiment is properly designed, two or more factors may be changed simultaneously and the methods of statistical analysis may be used to segregate the contributions of the individual factors to the observed effects. This type of experimental design is very economical of experimental effort. It is usually referred to as "factorial" design, and it involves evaluating each factor at all the chosen levels of the other factors instead of at just one level of those factors. This process reveals the dependence of any one factor effect on the levels of the other factors (called interaction), and constitutes a marked advantage over the usual arrangement of varying just one factor at a time.

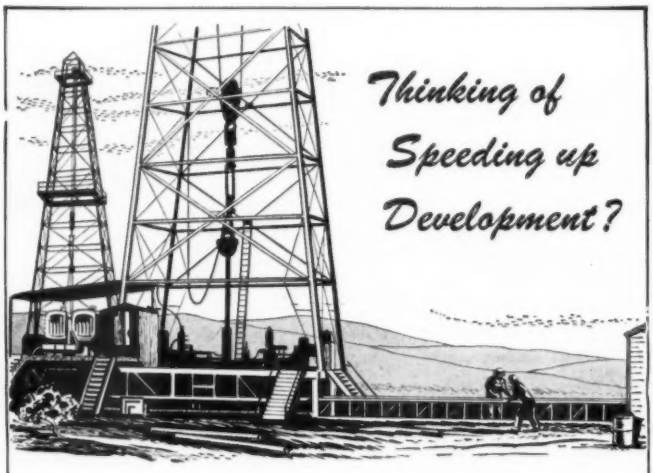
An additional feature of the factorial-design experiment is the determination of the inherent variability of the results and the comparisan of the magnitude of this variability with the magnitude of the effects due to changes in the several factors.

This statistically based design is particularly important in the case of field or plant testing where experimentation is costly and slow. In such cases also, the chance or inherent variability is likely to be great, and its reduction by more refined measurements or repeat experiments is a very expensive alternative.

Segregation of the several factor effects by mathematical calculation is possible because of the additive properties of "variance." Variance is the mean square of the effects caused by varying a given factor, and is thus the square of the standard deviation. In a two-step process or two-factor experiment, where the two steps have individual variances V_1 and V_2, the variance of the over-all result will be $V_1 + V_2$ (or the over-all standard deviation $s = (s_1^2 + s_2^2)^{1/2}$. By arranging the experiments in appropriate combinations, one can calculate for any number of factors—such as temperature, pressure, and feedstock type—the components of the over-all variance contributed by each factor. This process is called an "analysis of variance."

Factorial vs. classical design.—The economies afforded by factorial design may be illustrated by a simplified case of a pilot-plant program planned to select the optimum combination of two pressures and two temperatures to maximize conversion in a given process. An experimenter, using the classical approach, might normally start by making a couple of check runs at a given set of conditions, say 300° F. and 50 psig. Should these two runs not check closely, he might well make two more.

If experience had established that the standard deviation of the conversion of individual runs was 0.5 per cent, then simple calculation, using elementary statistical formulas, would show that standard deviation of the average of the four runs made would be $0.5/(4)^{1/2} = 0.25$ per cent. If he wished to ascertain the optimum conversion level within 1 per cent and wanted to be 95 per cent sure that a 1 per cent difference in average conversion between the various conditions used was real and not just a chance effect due to the variations in individual runs, he would conclude that it was necessary to make four runs at each pressure and temperature combination. Having tested



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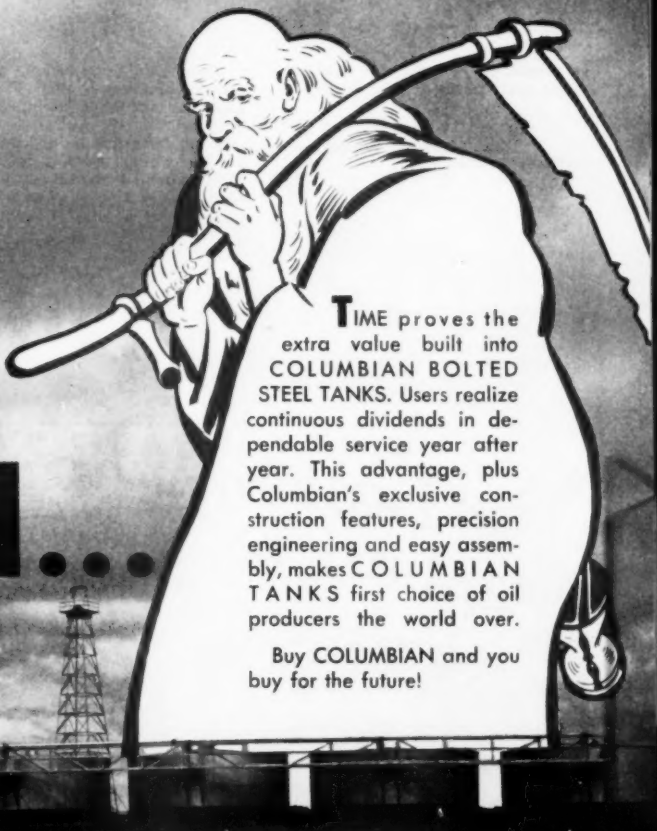

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combination A, the experimenter might then proceed with B and C.

Combination	No. of runs	Temp. (°F.)	Pressure (psig.)	Average conversion (%)
A	4	300	50	84.5
B	4	400	50	83.4
C	4	300	100	81.7

Observing a lower conversion at combination B, he would return to 300° F. and raise the pressure to 100 psig. A further drop in conversion would convince him that combination A represented the best combination; in other words, 300° F. was the best temperature and 50 psig. was the best pressure. It should be noted, however, that he required 12 runs to reach this conclusion, and that the combination of 400° F. and 100 psig. had not been included in this program.

Using factorial design, the experimenter would set out to try each combination of conditions but would require only two runs at each combination for a total of eight, as follows:

Combination	No. of runs	Temp. (°F.)	Pressure (psig.)	Average conversion (%)
A	2	300	50	84.8
B	2	400	50	83.1
C	2	300	100	81.7
D	2	400	100	86.0

The precision of the comparisons in this case would be equivalent to the precision originally sought in the classical design, since an analysis of variance could be used to make the pressure comparison, (the four runs A + B vs. the four runs C + D) and the temperature comparison, (A + C vs. B + D). In addition, the factorial approach insures testing all combinations, and in this case, the combination represented by D, which was omitted in the classical approach, proved to be superior. Presumably its superiority might have been due to the unpredicted suppression of side reactions at 100 psig. and 400° F.

The advantages of the factorial design and differences from the classical arrangement become more apparent as the number of factors is increased above two.

Evaluation of new instrumentation. The analysis of variance can also be very useful in disclosing the source of variance in sampling and testing procedures. It has been applied to evaluate a newly developed vapor-pressure recorder in comparison with conventional Reid vapor pressure determinations. Since the recorder gave readings on a stream which was continuously changing, it was different to obtain any independent estimate of the precision of the recorder. This was obtained, however, by using analysis of variance as follows:

First, a number of samples were double checked by the regular Reid vapor pressure test, A.S.T.M. D323. Duplicate routine inspections on 20 samples showed that the variance of the difference between rechecks was 0.0295. Since the variance of the difference of two recheck tests is twice the variance of the individual tests, it follows that the variance of the individual tests was 0.015 and the standard deviation was the square root of the variance or 0.12 lb. R.v.p.

The next step was to compare recorder readings with the corresponding inspection tests. This comparison necessarily included the effect of any variance due to sample handling prior to inspection. Twenty-eight comparisons between the vapor-pressure-recorder readings and routine inspections on samples drawn from the stream at the time of the readings were chosen at random from the hundred or more such comparisons available. Again the differences were tabulated, and their variance was calculated to be 0.270. This variance was the sum of the variance of the individual recorder readings plus the variance of the individual inspection test plus any variance due to sample handling prior to inspection.

Since the variance of the inspection test was shown above to be 0.015, the variance of the recorder readings plus sample handling effects (by the additive properties of variance) was 0.270 — 0.015 = 0.255, and the standard deviation was 0.50 lb. R.v.p. It was concluded, therefore, that the standard deviation due to the vapor-pressure recorder and sample han-

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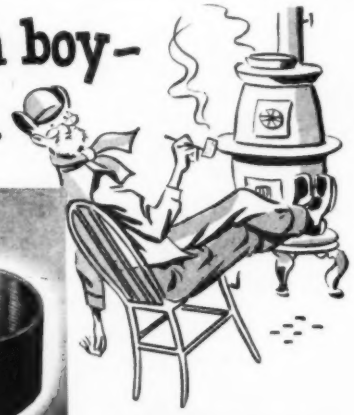

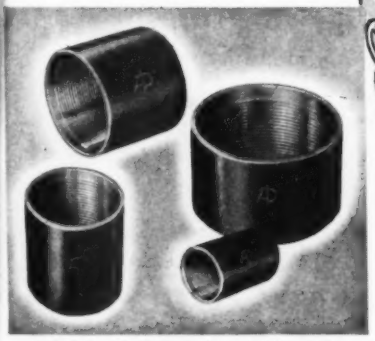

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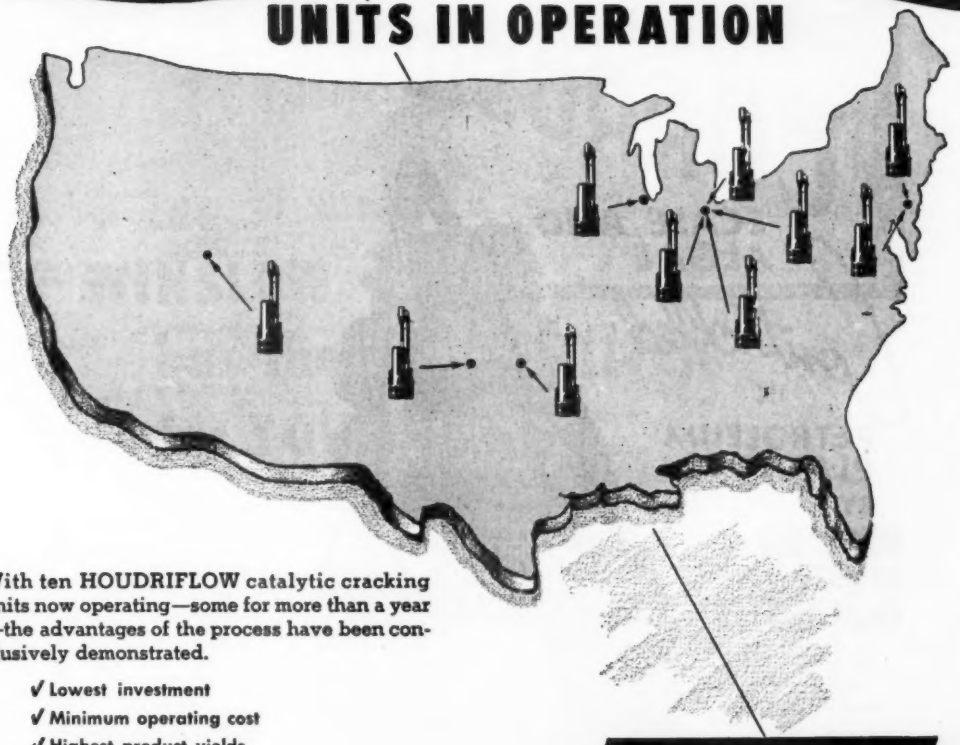

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dling was 0.50/0.12 = 4.2 times as great as that due to the routine inspections.

To compare the variance of the vapor-pressure recorder itself with that of the sample-handling technique, 45 sets of simultaneous readings for three recorders on the same stream were analyzed. The results indicated that the standard deviation of the recorders alone was 0.11 lb. R.v.p., or slightly lower than that of the A.S.T.M. laboratory procedure itself when manipulated with extreme care. From this it was concluded that approximately 90 per cent of the variance between the recorder and the conventional control-laboratory reports can be attributed to errors introduced by the present method of drawing samples and the method of handling these samples between the time they are drawn and the time they are used. Future efforts should be directed primarily toward the improvement of the sample-drawing and sample-handling operations.

Motor-oil mileage tests.—While the above simple examples illustrate the general principles of factorial experimental design and the usefulness of analysis of variance, the real advantages of this type of approach become more evident in full-scale experimental programs. This is by an analysis of the field-test program

TABLE 1—EXPERIMENTAL MOTOR-OIL MILEAGE TESTS*

(Miles per quart)

Car type and No. / Age group:	X	Y	Z	Wtd. avg.
Motor Oil A				
0-10,000 miles				
1	1,104	526	1,440	
2	733	1,020	505	
3	2,540	708	694	
4	1,110	728	739	
				1,198
10,000-20,000 miles				
9	746	971	650	
10	391	605	441	
				682
20,000-30,000 miles				
13	266	304	258	
14	289	313	369	
				305
30,000+ miles				
17	321	153	295	
18	385	430	157	
				299
Weighted averages:				
Oil and car type	941	668	624	
Oils		747		
Avg. deviation		±470		
Motor Oil B				
Car type and No. / Age group:	X	Y	Z	Wtd. avg.
0-10,000 miles				
5	1,605	2,100	762	
6	2,780	2,050	1,250	
				2,148
10,000-20,000 miles				
11	727	1,640	580	
				1,046
20,000-30,000 miles				
15	547	671	333	
				492
30,000+ miles				
19	306	295	175	
				252
Weighted averages:				
Oil and car type	1,134	1,852	724	
Oils		1,209		
Avg. deviation		±870		
Motor Oil C				
Car type and No. / Age group:	X	Y	Z	Wtd. avg.
0-10,000 miles				
7	1,086	2,530	1,232	
8	1,780	3,200	2,500	
				2,204
10,000-20,000 miles				
12	1,000	256	464	
				824
20,000-30,000 miles				
16	2,220	433	490	
				1,333
30,000+ miles				
20	461	242	174	
				344
Weighted averages:				
Oil and car type	1,522	1,420	1,223	
Oils		1,401		
Avg. deviation		±916		

*While each datum represents the average oil consumption observed during one to four 1,000-mile drain intervals on a particular car, the averages were weighted on the basis of the individual drain-interval data.

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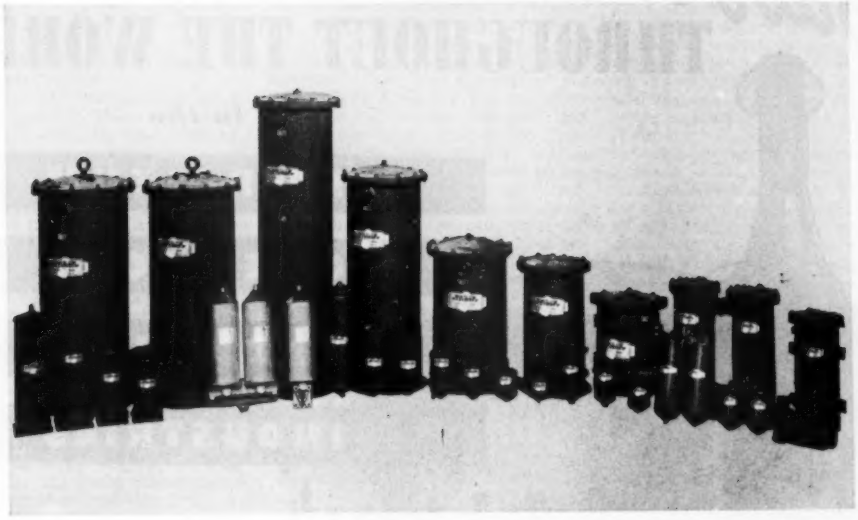

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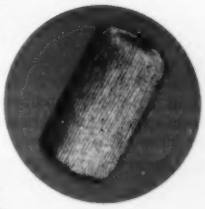

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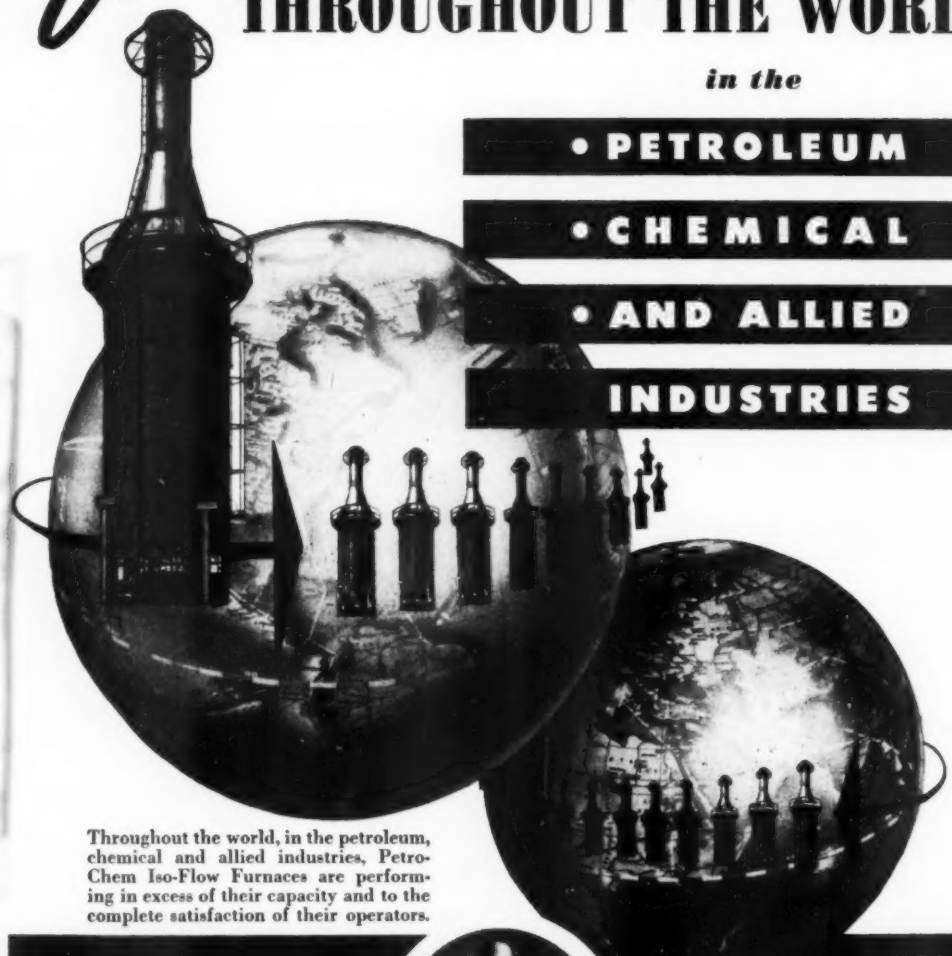

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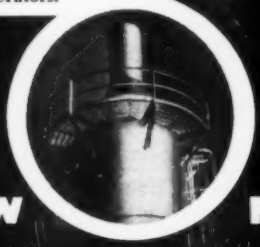

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originally designed without particular regard to the statistical approach. This program was aimed at measuring the consumption characteristics of three grades of experimental motor oils. The significance and confidence limits of the results will be reviewed first, followed by an analysis of the experimental design.

Sixty personal cars in normal urban use were involved. These were classified with respect to type and age group and each car was used to test only one oil. The test oil was weighed in and out, all crankcase draining was carried out while the oil was hot and at intervals of approximately 1,000 miles. The individual cars varied in the number of miles driven, so there were one to four drain intervals in each case. The basic outline of the program and the summarized results are given in Table 1.

The average oil mileage for all types of cars and age groups showed decided differences between oil types, with an apparent superiority for oil types B and C. The same differences applied in the case of the individual car types, although with varying magnitude. The age-group trends, however, were less consistent; in the second and fourth groups, particularly, differences were small. It is obvious that much of the variability may be accounted for by the differences between the individual cars.

Average deviations for the overall averages were 400-900 miles per quart, greater than the differences between the averages. In such a case, it is not possible, with the data available, to make a well-founded decision as to the significance of the results based merely on the averages and the average deviations. To make such a decision requires a statistical analysis of variance, which relates the variability or "standard deviations" between cars and between drain intervals to the probability of observing given differences between averages.

Summarized results of such an analysis of variance are shown in Table 2. The variabilities due to differences in successive drain intervals and to the differences between cars (both of which might be considered inherent in this type of field program) were both large, with standard deviations of 687 and 472 miles per quart, respectively. In view of these large inherent variabilities, the small differences observed between car types and between oil-and-car age groups could not be considered significant. There was a greater than 1-in-5 probability that these differences were due to the random comoination of cars and drain intervals in this particular program. The absence of a significant interaction between oil-and-car age groups is noteworthy, as it indicates that no one of the oils tested was selectively inferior in the older cars.

Age groups and oil types did show significant differences. The former is, of course, to be expected, since it is obvious that older cars on the average will use more oil. The significance of the differences between the types of oil, however, is somewhat surprising. Confidence limits for the three oil averages, calculated from the standard deviations, were in general narrower than the differences between Type A oil and the two other oils. It would appear, therefore, that the superiority of Type B and Type C oils is real, since there is only a 1.4 per cent and 0.07 per cent probability, respectively, that these differences were caused by chance alone. Thus, analysis of variance, while not changing the conclusions, has "defined the uncertainty," so that one knows how much reliance can be placed on the conclusions.

Factorial program design.—The arrangement of this experimental program already has the main elements of factorial design. Each type of oil was tested in each car type and each age group. Here classical design, trying out car types and age groups and selecting one of each as "average" to use in comparing the three oils, would obviously be unsuitable. There are two improvements, however, which might be made through a systematic factorial-design approach. The unbalance between groups could be eliminated; that is, the same number of drain intervals could be used for each oil and, at the same time, the over-all

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TABLE 2—ANALYSIS OF VARIANCE EXPERIMENTAL MOTOR-OIL MILEAGE TESTS

Standard deviation due to drain intervals ..... 687 miles per quart
Standard deviation due to individual cars ..... 472 miles per quart
Standard deviation due to cars and drain intervals = $(687^2 + 472^2)^{1/2}$ = 834 miles per quart

Variance source—	Significance	Probability of observing such variance by chance alone
Interaction between oil-and-car type	None	Over 20%
Car type	None	20%
Age group	Significant at 0.1%	Less than 0.1 %
Oil type	Significant at 0.5%	0.5%

Oil type	A	B	C
Number of drain intervals	76	30	38
Average oil mileage ± confidence limit	747 ± 189	1,209 ± 301	1,401 ± 268
Confidence range (95 per cent)	558 — 936	908 — 1,510	1,133 — 1,669
Probability of observing difference by chance alone		1.4%	
			0.07%

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number of drain intervals could be reduced.

Whenever it is planned to compare a factor at two or more levels, such as three types of oil in the present case, the greatest efficiency is achieved by running the same number of tests on each. If the difference between two means is to be significant, the standard deviation of this difference should be minimized.

For the same total number of tests, the standard deviation of the difference will be at a minimum when $n_A = n_B$. In the comparison between oil Types A and B, for example, there were 76 and 30 drain intervals, respectively, but the probability level would have been reduced from 1.4 to 0.6 per cent by making 53 drain intervals on each oil, from the same total of 106 drain intervals. Thus, the experimental arrangement that led to a confidence limit of ±189 miles per quart for Type A oil was wasteful in that the comparison was handicapped by the less precise averages available for Type B and C oils. An even more important handicap was the introduction of the "between car" variation, which might have been eliminated by the use of each car on all three types of oil.

In any experimental program, one of the primary objectives of the experimenter is to obtain results of sufficient accuracy to enable him to reach valid conclusions. Precise measurements and good technique are obviously necessary for accurate results. Beyond this point, the effect of inherent small, random errors upon the accuracy can only be overcome by replicating the experiment. If the magnitude of the inherent errors is known, then the number of replications (n) necessary to achieve the desired accuracy, may be calculated using the confidence-limits equation in its generalized form:

$$n = \frac{t^2 \times V^2}{E^2} \qquad (1)$$

where

t = factor based on the probability level chosen.
V = coefficient of variation — the standard deviation expressed in per cent.
E = confidence limit chosen, expressed in per cent.

If the number of replications indicated by Equation 1 is too great to be practical, there is no means of achieving the desired accuracy other than to undertake research to refine the experimental techniques and measurements and thus reduce the inherent error.

In using this approach to design a motor-oil test program equivalent to that given above, one would proceed as follows:

The smallest confidence limit in the above program (Table 2) was 189 miles per quart, on Oil A. On a percentage basis, with the average mile-

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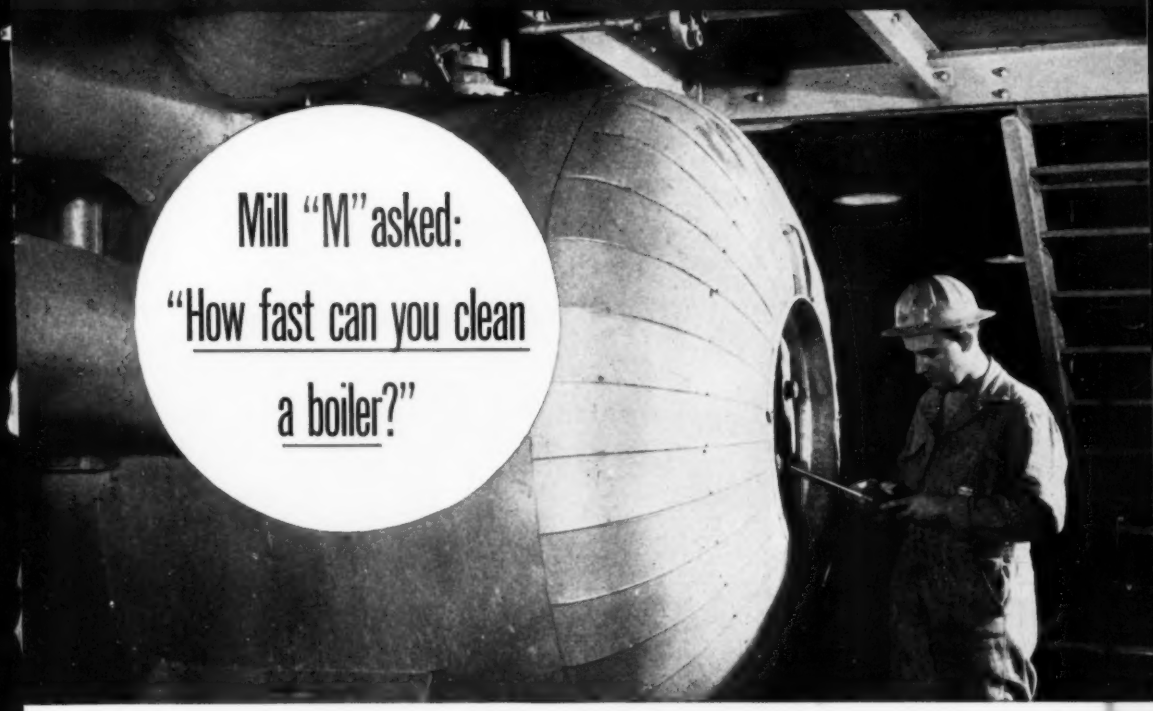

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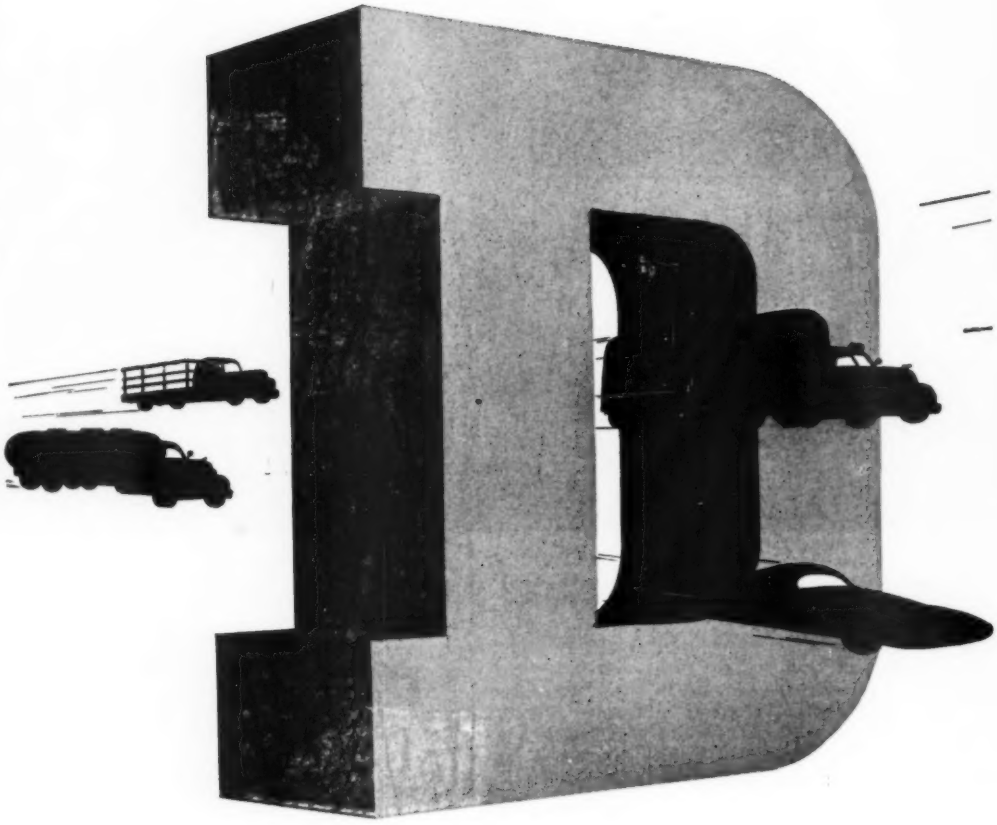

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TABLE 3—MILEAGE TEST PROGRAM—FACTORIAL DESIGN BASIS

Car type—Car-age group:	Car No.	Motoroil A			Motor oil B			Motor oil C		
		X	Y	Z	X	Y	Z	X	Y	Z
0-10,000	1	X(1)*	X(2)	X(3)	X(2)	X(3)	X(1)	X(3)	X(1)	X(2)
		X	X	X	X	X	X	X	X	X
	2	X(3)	X(2)	X(1)	X(2)	X(1)	X(3)	X(1)	X(1)	X(2)
		X	X	X	X	X	X	X	X	X
10,000-20,000		Same pattern as 0-10,000 car-age group								
20,000-30,000		Same pattern as 0-10,000 car-age group								
30,000+		Same pattern as 0-10,000 car-age group								

Total cars = 2 each of 3 types of 4 ages = 24

Drain intervals = 2 per car per oil, 6 per car total
= 12 per age group per oil, 48 per oil total
= 144 total

Car months = 24 cars × 6 drain intervals × 1.67 months/drain interval = 240

*The parenthetical numbers refer to the sequence with which the different oils were tested in each car.

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age assumed to be 1,000 miles per quart, E would be 18.9 per cent. It would obviously be desirable to use each car on all three oils and thus to eliminate the effect of the individual car variation. This would leave as the inherent error the standard deviation due to drain intervals, or 687 miles per quart. Thus, V = 68.7 per cent. From the selected 95 per cent probability level, t = 1.96. By substitution in the above equation, one may calculate the drain intervals required on each oil to achieve the desired confidence limits of 189 miles per quart:

$$n = \frac{1.96^2 \times 68.7^2}{18.9^2} = 51 \qquad (2)$$

The next step is to select the optimum arrangement of these 51 drain intervals. If the 3 car types and 4 age periods are retained in addition to the three oils), there are 12 categories within which to replicate cars and drain intervals on each oil. It will therefore be more convenient to make "n" the nearest multiple of 12, namely 48 instead of 51, since it would not be possible to balance the groups of cars and drain intervals with an odd number of replicates.

The groups can be balanced by including two drain intervals on each of two cars in each car-type and car-age group ($2 \times 2 \times 3 \times 4 = 48$). This leads to an experimental design as illustrated in Table 3. Each car is tested on all three oils, rather than just on one oil, and the sequence of the oil types in the two cars of a given make and age group is adjusted to minimize any systematic aging effect in individual cars.

This factorial-designed program requires the use of only 24 cars or 40 per cent of those used in the actual program. The precision, reduced from 189 to 195 miles per quart by the use of only 48 drain intervals, is still considerably improved over that obtained for oil Types B and C in the actual program.

One disadvantage imposed by the factorial design is the increase in elapsed time. It would require 10 months to run through the six drain intervals in each car, instead of the 4 months required in the actual program using more cars. Where it is feasible to tolerate this increase in elapsed time, however, to realize the economies in reducing the number of cars used, the savings available through the use of factorial design would be substantial.

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K. A. Brownlee, "Industrial Experimentation," Chemical Publishing Co., Inc., Brooklyn, New York, 1947.

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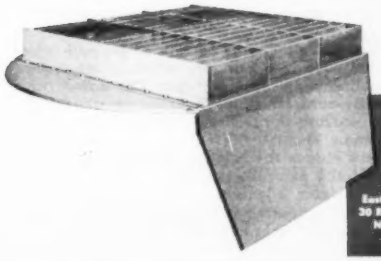

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Capillary Properties of Some Limestone Cores

by Robert L. Whiting and Erasmo T. Guerrero

The petroleum engineer and geologist, in their efforts to predict the quantity of hydrocarbons in place in a reservoir, future productivity, and ultimate recovery from the reservoir, have long recognized the need for adequate information describing thet characteristics of the reservoir fluids, porous media, and the behavior of these fluids in porous media under flowing conditions. This article deals with the laboratory determination of several physical properties and the fluid conductivity of porous media. Robert L. Whiting, is professor in Texas A. & M.'s department of petroleum engineering, and research engineer with Texas Engineering Experiment Station. E. T. Guerrero is a Stanolind Oil & Gas Co. fellow (1949-50) at Texas A. & M.

THE determination of the capillary pressure - saturation relationship for a core (or group of cores) is useful in predicting the pore-size distribution in the core. Practically, these data are used to describe the fluid-saturation distribution in the reservoir. Recent laboratory research on this problem has been directed toward more closely simulating reservoir conditions in the tests and increasing the speed of the determination. This article presents information relative to the latter development.

The prediction of the future performance of a petroleum reservoir requires the extrapolation of the past-performance history or the use of laboratory fluid-flow data. When using the latter method, relative permeability-saturation data are required. Considerable difficulty has been experienced by numerous investigators in obtaining accurate, reproducible, laboratory fluid-flow data that simulate reservoir conditions, on relatively small core samples. This article presents the results of laboratory determinations of relative permeability for large-diameter limestone cores and discusses the influence of several factors on these determinations.

Experimental Equipment and Procedures

The cores that were studied in this investigation were large - diameter Edward's limestone cores obtained from Darst Creek field in Guadalupe County, Texas.

The cores as obtained from the field contained a considerable quantity of water and oil. These cores were first sized to fit into the processing and testing equipment. The fluids from each core were then extracted through use of large-scale extraction equipment. In some cases 4 weeks of constant extraction were required before the dry weight of a core remained constant.

The porosity of each of the clean, dry cores was then determined by the saturation method after the cores had been

ENGINEERING *Reference Section*

evacuated and saturated with distilled water.

Static capillary pressure-saturation data (air-water), employing the porous diaphragm method, were then obtained for each core. Specially constructed, large-diameter, lucite capillary-pressure cells were used in these tests. At least one set of duplicate results was obtained for each core.

The cores were then dried and the dry weight of each core was determined. The clean dry cores were then set in lucite using a low temperature-low pressure molding method.[1 2] Sodium chloride paste rings were spaced along the length of each core to divide the core into a number of sections. The brine paste rings were dissolved in water after the core had been set in plastic. Suitable connections were then provided to facilitate pressure measurements along the length of the core. Brass, shim-stock electrode rings were spaced along the core to permit conductivity measurements in the different sections of the core.

After the cores had been set in the lucite and the core units prepared for testing, the permeability of each sample and each section in each sample was determined.

After these determinations, the cores were evacuated and saturated with brine, 20,000 p.p.m. Suitable auxiliary equipment, which would permit the determination of the wetting fluid (brine) saturation and the relative permeability of the medium to air, was assembled. A diagram of the testing equipment arrangement is shown in Fig. 1.

Relative Permeabilities; Capillary Pressures

In the relative-permeability tests, a core, previously saturated with brine, was progressively desaturated by admitting air to the upstream side of the core at successively higher pressures, maintaining the discharge pressure at atmospheric pressure. Equilibrium was established at each injection pressure before data were taken. The brine saturation of the entire core was determined gravimetrically and the brine saturation in each section was determined by conductivity measurements. These tests were made for the core in the horizontal position and with flow vertically downward. Duplicate runs were made for each series of runs for each core.

Air-relative permeability tests on the cores were also made under conditions of simultaneous flow of air-water mixtures through the core.

CONCLUSIONS

1. The results of capillary pressure measurements when employing the porous diaphragm and the mercury-injection method can be made identical by proper choice of the conversion factor. Conversion factors for limestone cores were found to range from 5.25 to 10.1.

2. Equilibrium wetting fluid (brine) saturations, for a particular core were found to be higher when employing the dynamic capillary pressure method, utilizing stepwise air injection to obtain brine desaturation, than when using the static capillary-pressure method.

3. The correlation of the experimental data in the form of the capillary retention relationship is such as to be of only qualitative value.

4. In measurements in which wetting-fluid desaturation is obtained by stepwise air injection the influence of the boundary effect on the nonwetting fluid (air) conductivity of a core is very great at high brine saturations. However, the boundary effect becomes of less influence at low brine saturations, corresponding to relatively large pressure gradients and flow rates.

5. In measurements employing steady-state injection of air and brine into a previously brine-saturated core the boundary effect is much less pronounced than in stepwise air-injection measurements. The nonwetting (air) phase relative permeability-saturation relationship is dependent upon the method employed in securing the desired wetting-fluid saturation and also upon the saturation history.

6. In the absence of boundary effects the relative permeability to air was found to be independent of the pressure gradients and flow rates when employing steady-state air-water injection.

7. No correlations between relative permeability to air and capillary pressure, permeability or rock textural characteristics were found.

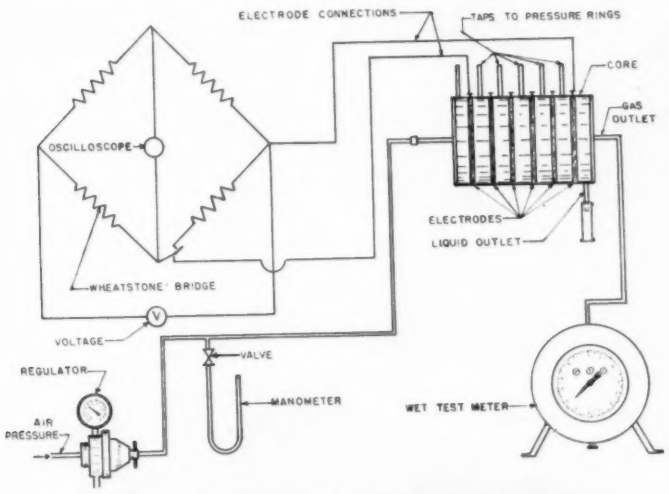

Fig. 1—Apparatus arrangement for determination of relative permeability.

Decreasing saturation of the wetting fluid (brine) was obtained by increasing the air-water injection ratio, at constant pressure, on successive runs. Data under similar flow conditions were taken at different injection pressures.

The capillary pressure-saturation relationship for some limestone cores was determined by the mercury-injection method. The mercury capillary-pressure apparatus, similar to that originally used by Purcell,[3] is shown in Fig. 2. The primary difference between this apparatus and that used by previous investigators is that the sample chamber was of such a size that it would accommodate a core of 3-in. diameter and 5-in. length.

Results

1. General physical properties.—Data for the cores are shown in Table 1.

TABLE 1—DATA FOR CORES

Core No.	Cross-sectional (area) sq. cm.	Length cm.	Porosity per cent	Permeability md.
1	59.5	5.3	24.0	7.85
2	59.4	10.4	37.2	246
2A	56.7	4.0	39.4	242
3	59.5	10.9	25.6	8.27
4	59.5	4.6	26.6	8.35
5	58.1	5.5	31.1	102

All of these cores were approximately 3½ in. in diameter and their lengths ranged from 4.0 to 10.9 cm. The cores are characteristically very porous, fined grained, chalky limestone. Their porosities ranged from 24.0 to 39.4 per cent while their permeabilities ranged from 7.85 to 246 md.

Since these core samples were taken in the conventional manner used in rotary drilling, the permeabilities reported in this work represent vertical permeability determinations in the Edwards limestone cores. In the original visual examination of the cores, immediately after extraction and drying, no bedding planes or apparent tight streaks were noted in the cores. However, the air permeability data shown in Fig. 3 indicate that within a core the permeability was found to vary over a wide range. For example, in the case of core 2, the permeability ranged from 135 to 378 md.

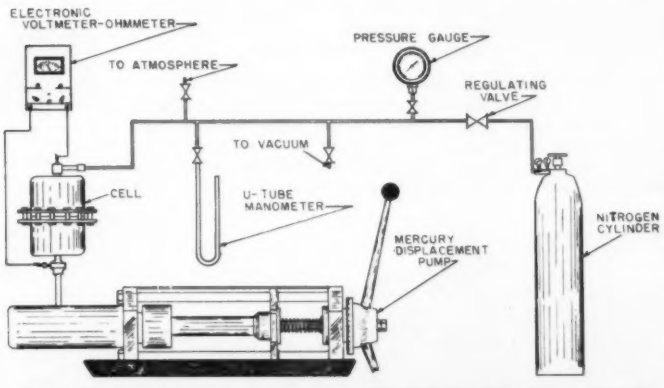

Fig. 2—Diagrammatic layout of apparatus for determining mercury capillary pressures.

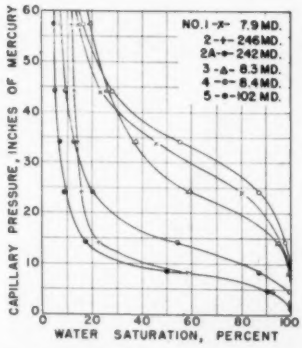

Fig. 3—Static capillary curves for Edwards limestone cores.

2. Static capillary pressure-saturation measurements.—The results of these tests are shown in Fig. 3.

In these core tests it is observed that the curves have the usual shape of capillary-pressure curves obtained for sandstone cores. However, it should be noted that at high brine saturations, particularly for the low-permeability cores, a decrease in wetting-fluid saturation is observed at a relatively small capillary pressure. This observation becomes of significance in the preparation and use of correlative data relating wetting-fluid saturations and rock textural characteristics.

Previous investigators have predicted rock textural characteristics upon the basis of the extrapolation of capillary pressure-saturation data at relatively high capillary pressures. This method results in high values for the rock textural characteristics. The results of the work reported in this paper indicate that a finite threshold pressure exists but in the majority of the cases this pressure is very small. Unfortunately, the pressure limit of the test apparatus did not permit the determination of the minimum interstitial water saturation for the low permeability cores.

The results show the characteristic grouping of cores according to permeability. For a given capillary pressure the lower permeability cores

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have greater water saturations than the higher permeability cores.

3. Mercury injection capillary pressure-saturation.—The capillary pressure-saturation relationship for many limestone and sandstone core samples have been determined by the writers utilizing the mercury-injection method. Ordinarily the results obtained by this method are similar to those obtained when employing the capillary-diaphragm method. It has been found that the results obtained by the two methods can be made to appear identical by proper choice of the conversion constant that is used to change the mercury-injection data to equivalent air-water data.

Typical results for a limestone core are shown in Fig. 4. The mercury-injection data are presented on this plot in terms of equivalent air-water data. In this particular case a conversion factor of 10.1 for the mercury-injection data was required to produce the indicated similarity of results.

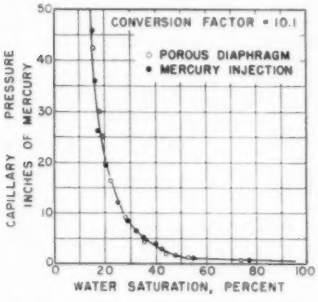

Fig. 4—Capillary pressure results by porous diaphragm and mercury-injection methods.

Several methods have been employed in estimating this conversion factor but to date no method has proved applicable for use in all cases. Perhaps the simplest method of estimation of the factor is the one in which the threshold pressures are determined by both the capillary-diaphragm method and the mercury-injection method. The conversion factor is then calculated from these data using the mercury-injection data. However, this method of estimating the conversion factor may lead to considerable error since even though it is quite easy to measure the threshold pressure using the mercury-injection method it is frequently most difficult to determine when using the capillary-diaphragm method. The results indicate that greater accuracy is obtained by this method when examining cores of low permeability. This can probably be explained by the fact that low-permeability cores ordinarily have relatively high threshold pressures and hence its evaluation by both methods is more accurate.

If the capillary pressure-saturation curve for a core is flat over a fairly wide range of saturations one point, at a relatively high wetting-fluid saturation, can be obtained by the capillary-diaphragm method and related to the same wetting-fluid saturation when employing the mercury-injection method. Using these data the conversion constant can be estimated and the remainder of the capillary pressure-saturation curve can be calculated from the mercury-injection data. The accuracy of the predictions by this method seems to increase as the capillary curves become flatter in characteristic.

In Purcell's[5] original application of this method to the petroleum industry he used a conversion factor of 5.0 to correlate the data. However, he did not attempt the type correlation discussed in this paper but recently Brown[9] has attempted such a correlation. If a capillary system consisting of a bundle of straight circular capillaries tubes is assumed, the conversion factor for the mercury-nitrogen data to equivalent air-water data would be 5.25. However, it is evident that the porous structure of the majority of cores is much more complex than this and hence it is to be expected that the conversion factor will vary with the lithologic characteristics of the rock.

To date, conversion factors in loose

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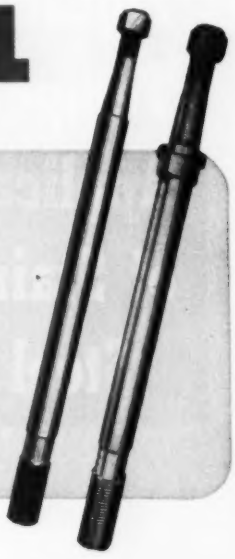

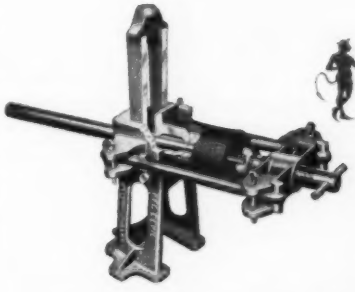

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to well-consolidated limestone and sandstone cores have ranged from 5.0 to 10.1. Efforts to correlate the conversion factor with the lithologic properties of the rock using the permeability and the dimensionless capillary-pressure function have been unsuccessful. However, it is believed that such a correlation exists, and in the presence of sufficient statistical data it is applicable to the estimation of the conversion factor.

4. Dynamic capillary pressure-saturation measurements.—Results for the over-all length of the Edwards limestone cores are shown in Fig. 5.

In obtaining these results, each core was originally saturated with brine. Air at constant pressure was then injected into the core maintaining the downstream pressure at atmospheric pressure. When equilibrium was secured at the constant air-injection pressure, the brine saturation was measured in each section and for the over-all length of the core. The air-injection pressure was then increased and similar data taken after equilibrium had been established.

The curves are very similar in shape and relative position to the corresponding curves obtained in the static capillary pressure-saturation tests. As in the case of the static capillary pressure-saturation tests these curves exhibit the characteristic shape of sandstone cores and group themselves according to their permeabilities. An examination of the results shows that in all cases for a particular core at a given capillary pressure, a higher wetting-fluid saturation is observed by the dynamic process than by the static process. For a particular core, a higher minimum interstitial-water saturation is obtained in the dynamic tests than in the static tests, where such data are available.

Since the results reported in Fig. 6 are for the over-all length of the cores it was thought that the boundary effect, hysteresis, gas expansion, etc., might influence the accuracy of the results. In order to evaluate the influence of these variables on the results the brine-saturation profiles for Edwards limestone cores Nos. 2 and 3 are shown in Figs. 6 and 7, respectively.

The brine-saturation profiles for Edwards limestone core No. 3, which has a permeability of 8.27 md., indicates that at low air-injection pressures, corresponding to low capillary pressures and high brine saturations, the wetting-fluid (brine) saturation increases toward the outlet face of

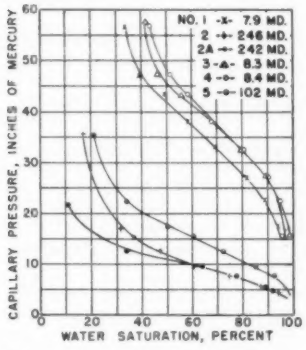

Fig. 5—Plots of dynamatic capillary pressure-saturation measurements. Results for over-all length of the Edwards limestone cores.

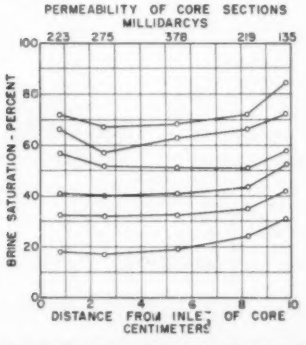

Fig. 6—Brine-saturation profiles existing during stepwise air injection into brine-saturated Edwards limestone core No. 2.

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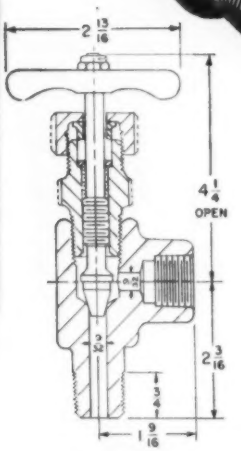

ANGLE VALVE
Fig. 153J

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153J—1 lb, 14 oz.
152J—1 lb, 14 oz.

EDWARD FIG. 152J GLOBE GAGE VALVE IN ONE OF MANY INSTALLATIONS ON CHRISTMAS TREE.

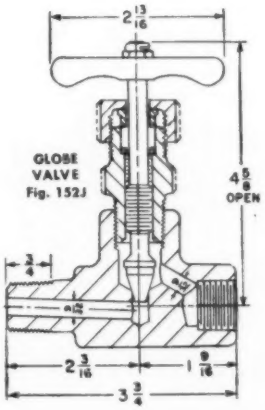

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Fig. 152J

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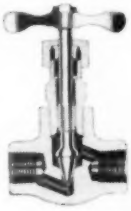

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the core. This so-called "end effect" certainly does have an influence on the shape of the dynamic capillary pressure curve particularly at high brine saturations. Unquestionably, this is, at least in part, an explanation of the high brine saturations obtained at high capillary pressures particularly for the low-permeability cores. However, it is noted in Fig. 7 that as the capillary pressure is increased the boundary effect has less influence on the shape of the profiles. It is believed that the boundary effect has a negligible influence on the two lowermost profiles. In view of the fact that the cores were not homogeneous it was to be expected that the wetting-fluid saturation would vary along the length of the core. It should be noted that in the absence of the boundary effect, for a particular air-injection pressure, the brine saturation in any section of the core is related to the permeability of the section. The higher the permeability the lower the brine saturation.

An examination of the saturation profiles for Edwards limestone core No. 2 shown in Fig. 6 leads to similar observations. However, it is noted that the boundary effect is of smaller magnitude in this core than in the former. This is probably due to the fact that core No. 2 had a relatively high permeability, 242 md.

Hence, it is conceded that the boundary effect does influence the results shown in Fig. 5. The resultant effect is to shift the static capillary pressure curves to higher brine saturations, at a particular capillary pressure. However, at the high capillary pressures the boundary effect is not of sufficient magnitude to explain the difference in the static and dynamic capillary pressure curves. Slobod[8] has suggested that such anomalous results may be due to the fact that an insufficient quantity of nonwetting phase has been passed through the core to obtain equilibrium wetting-fluid saturation. This is not believed to be the explanation for the results in this case since at the high air-injection pressures a large number of pore volumes (5,000 minimum) of the nonwetting phase were passed through the cores before equilibrium was obtained.

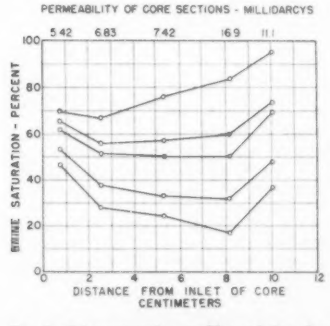

Fig. 7—Brine-saturation profiles existing during stepwise air injection into brine-saturation Edwards limestone core No. 3.

There has been considerable disagreement among recent investigators as to the applicability of static capillary pressure data to dynamic fluid-flow problems. An examination of the more recent literature[5,6,7,8,9] indicates that in general when small-diameter high-permeability cores have been studied under both static and dynamic conditions there is little difference in the results obtained in the two types of tests and that the minimum interstitial-water saturation obtained by the static tests is approximately the same as that obtained in the dynamic tests.

Recently, Brown[9] has compared the results obtained in static and dynamic capillary-pressure tests. In a dynamic test, employing a homogeneous core and maintaining equal capillary pressures at each end of the core, he found that the wetting-fluid saturation was constant throughout the core and that the minimum interstitial-water saturation was the same by the dynamic and static processes. However, in a number of studies[10,11,12] involving long, large-diameter cores it has been observed that there is a considerable difference in the results

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obtained in the static and dynamic tests.

Holmgren[12] and others have made the observation that the maximum desaturation of the wetting phase in the core, produced by the entrance of a nonwetting phase under pressure, is obtained in the static type test. The results of the investigation reported in this paper are in accord with this generalization. Rose[21] has suggested that the minimum interstital-water saturation obtained in a test is defined by the conditions of flow during the test. Hence, the minimum interstitial-water saturation obtained in the dynamic test becomes equal to that obtained in the static test in the limiting case.

5. Capillary retention relationships.—An effort was made to correlate the capillary properties of the porous media under study with the rock textural characteristics.

Leverett's[14 15] capillary retention relationship was employed in this correlation. This relation may be written

$$j(S_w) = P_c/\gamma \cos\theta \ (K/f)^{1/2}$$

where:

$j(S_w)$ = dimensionless capillary pressure function
P_c = capillary pressure
γ = interfacial tension between the two fluids
K = permeability
f = porosity
θ = contact angle between the fluid interface and the solid.

The results of this correlation for the Edwards limestone cores are shown in Fig. 8. Since all the cores

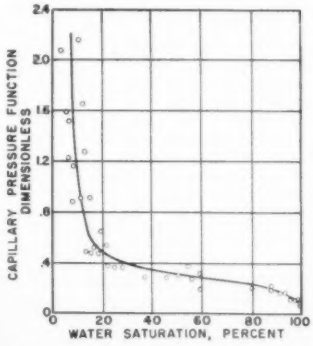


Fig. 8—Capillary liquid retention in Edwards limestone cores.

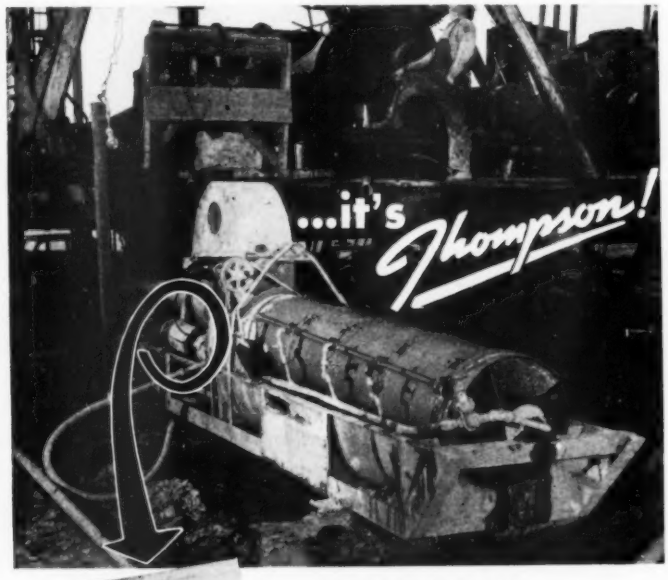
that were studied were of the same lithologic classification an average curve was drawn through the data. A cursory examination of the results suggest that the correlation is fairly good. However, if the average curve is used and the permeability of an individual core is calculated from the curve and compared with the measured permeability of the core, it is found that differences as great as 500 per cent are obtained. This result suggests that when the correlation is employed to describe the characteristics of an individual core the result is of only qualitative value.

An effort was also made to correlate water saturations with permeability and Kozeny surface area. In the opinion of the writers the results were of purely qualitative value. In the case of the latter correlation the accuracy of the results depends upon the accuracy with which the limiting value of the capillary-pressure function is read. In view of the extremely low threshold pressures possessed by these cores the limiting value approached zero.

6. Air relative permeability-saturation relationship.—Results for the over-all length of the Edwards limestone cores are shown in Fig. 9. In these tests, the previously brine-saturated core was progressively desaturated by the injection of air. Each successive run was made at a higher air-injection pressure with the downstream pressure maintained constant and equal to atmospheric pressure.

The curves are of varied shape and position on the relative permeability-saturation diagram. Efforts to correlate the characteristics of these air relative permeability-saturation curves with permeability and minimum interstitial-water saturation proved unsuccessful.

Here again the accuracy of the



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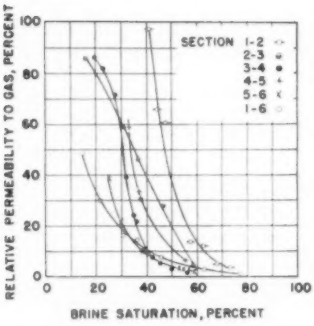

Fig. 9—Relative permeability to gas for various sections of Edwards limestone core No. 2.

results for the over-all length of the core can be questioned since at the higher brine saturations a boundary effect was observed. However, as the air-injection pressure was increased the influence of this boundary effect was decreased until it was believed to be of little effect.

It was thought that the results might be dependent upon the method employed in attaining a given wetting-fluid saturation. Hence, similar data were taken as air and brine were injected simultaneously (at constant injection pressure) into a previously brine-saturated core. Decreasing brine saturation was obtained by increasing the air-brine ratio on successive runs. The saturation profiles for this series of runs on Edwards limestone core No. 2 are shown in Fig. 10. These results indicate that at high brine saturations there is a general increase in brine saturation toward the outlet of the core. This suggests that a boundary effect is present. However, the fact that the permeability of the section closest to the outlet face is the lowest in the core may account at least in part for this result. The saturation profiles are much flatter in this type of test than in the tests employing only air injection.

The influence of the method of

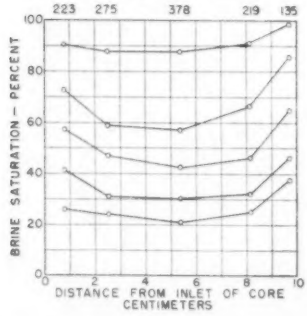

Fig. 10—Brine-saturation profiles existing during simultaneous air-water injection into brine-saturated Edwards limestone core No. 2.

TABLE 2—PHYSICAL CHARACTERISTICS OF EDWARDS LIMESTONE CORES

	DCF 3					
Section numbers	1	2	3	4	5	6
Permeability, md.	5.40	6.83	7.42	16.9	11.1	
Length, cm.	1.5	2.3	3.3	1.8	1.5	

	DCF 2					
Section numbers	1	2	3	4	5	6
Permeability, md.	223	275	378	219	135	
Length, cm.	1.5	2.0	3.8	1.8	1.3	

	DCF 1				DCF 2A			
Section numbers	1	2	3	4	1	2	3	4
Permeability, md.	9.2	10.4	4.2		138	252	273	
Length, cm.	1.1	3.1	1.1		.9	2.2	.9	

	DCF 4				DCF 5			
Section numbers	1	2	3	4	1	2	3	4
Permeability, md.	6.3	11.5	5.5		120	108	82	
Length, cm.	.9	2.8	.9		1.1	3.3	1.1	

obtaining wetting-fluid saturation on the air relative permeability-saturation results is shown in Fig. 11. The results are plotted for section 2-3 in Edwards limestone core No. 2. It is believed that fluid-flow measurements in this section were not influenced

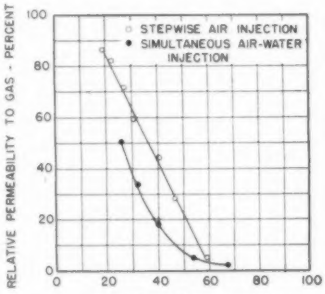
STEPWISE AIR INJECTION
SIMULTANEOUS AIR-WATER INJECTION
RELATIVE PERMEABILITY TO GAS - PERCENT
BRINE SATURATION - PERCENT

Fig. 11—Influence of saturation history on the relative permeability to gas for Section 2-3 of Edwards limestone core No. 2.

by boundary effects in either of the methods employed in obtaining brine desaturation of the core. The results show that at a given brine saturation, a higher air relative permeability is obtained when the brine saturation is obtained by air injection only, than when simultaneous air-brine injection is employed.

Similar air relative permeability-saturation results are presented in Fig. 12 for the over-all length of Edwards limestone core No. 2. For the over-all length of the core there seems to be very little difference in the results by the two processes.

Tests were also conducted on Edwards limestone core No. 2 to study the effect of pressure gradient on the air relative permeability-saturation results when employing simultaneous air-brine injection. For this relatively high-permeability core it was found that the pressure gradient had no effect on the results over a pressure gradient range of 1.36 psi. per inch to 4.20 psi. per inch.

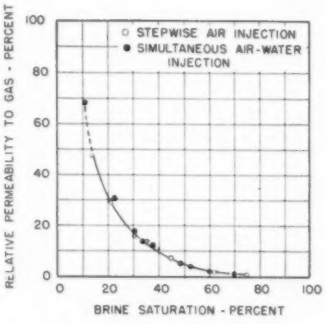
STEPWISE AIR INJECTION
SIMULTANEOUS AIR-WATER INJECTION
RELATIVE PERMEABILITY TO GAS - PERCENT
BRINE SATURATION - PERCENT

Fig. 12—Influence of saturation history on the relative permeability to gas for Edwards limestone core No. 2.

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Gamma-Ray Logging

by F. P. Kokesh

Gamma-ray logging has been used by the oil industry for at least 10 years. In spite of this comparatively long period of use, there is still much that is not generally known about the technique of recording and interpreting gamma-ray logs. This article is designed to bring out some of the underlying factors of certain problems of gamma ray logging and interpretation, such as the statistical nature of gamma rays, picking bed boundaries, and correlation with the electrical log. A few of the practical uses of gamma ray log will also be mentioned. The article is based primarily on experience in South Louisiana and the actual examples are from that area. However, the basic principles of operation and interpretation are applicable everywhere.

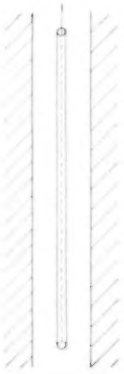

Fig. 1—Schematic arrangement of Geiger-Muller counter.

ENGINEERING *Reference Section*

IN discussing gamma rays, and if we are to start somewhere near the beginning, it would be natural to ask "what are gamma rays?" Gamma rays are electromagnetic waves similar to light rays and X-rays, but of much higher frequency even than X-rays and therefore of much greater energy. Because of their high energy they are capable of penetrating appreciable thicknesses of solid materials such as steel, concrete, and geologic rocks.

Sources of Gamma Rays

The gamma rays with which we are concerned here are generated by spontaneous changes in the structure of the nuclei of certain so-called radioactive elements. Commonly known radioactive elements are uranium, radium, and thorium. Other radioactive elements found in the earth are mostly their resultant products and a certain isotope of potassium. All geological formations contain greater or lesser quantities of radioactive elements.

Radioactivity of Various Formations

In general, shales are more radioactive than sands. There is no hard and fast rule regarding the radioactivity of shales and sands, and occasionally sands are more radioactive than shales. This is understandable, since the radioactivity is not necessarily related to the physical character of the formation, but rather it depends upon the distribution of minute quantities of radioactive elements which perchance were laid down with the formation or were later introduced by the circulation of formation fluids. Nevertheless, shales, sands, limes and other rocks are sufficiently different in their radioactivity as to make this parameter usable for differentiating one formation from another.

Detection of Gamma Rays—the Geiger Counter

Gamma rays can be detected only by the effects that they produce. One of these effects is that when they encounter a free electron they impart all or part of their energy to the electron and set it in more or less rapid motion. Use is made of this fact in a gamma-ray detector known as the Geiger Muller counter. The Geiger Muller counter (Fig. 1) consists of a metal tube which is either evacuated or filled with a special gas at a certain pressure. In the simplest form, this tube has running down through its center a conductor which is insulated from the outer shell. Impressed between the shell and the cen-

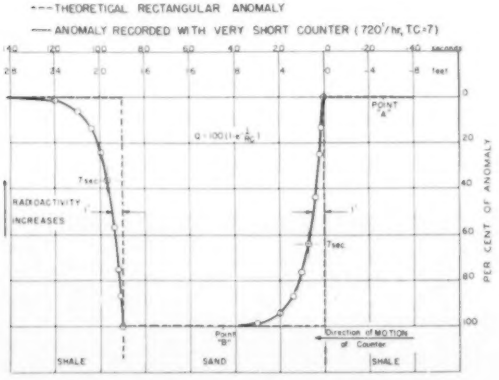

Fig. 2—Theoretical anomalies, sand-shale contacts.

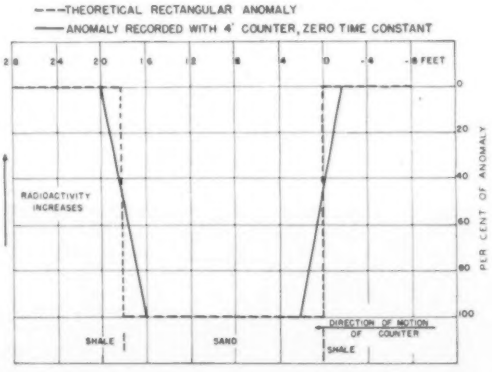

Fig. 3—Effect of length of Geiger counter.

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tral wire or anode, is a high potential of the order to 1,000 volts.

If we imagine that the Geiger counter is situated in a bore hole and that the surrounding formations are emitting gamma rays, some of these gamma rays will hit the counter. In doing so, they may collide with a free electron in the metal of the outer shell. The expression "may collide" is used because it is possible for a gamma ray to pass all the way through the counter without hitting an electron. The energized electron then may travel through the interior of the tube and in doing so it will ionize the gas within.

Ionization of the gas between the central anode and the outer shell will permit current to flow between the two under the force of the potential between them. The ionization will spread at a very rapid rate throughout the counter and a strong pulse of current will rush through it. However, an instant after the current starts to flow, it is cut off, or quenched. The quenching can be accomplished in various ways, but the method is not of importance at this time. It can be seen that one gamma ray impinging upon the counter may cause a pulse of current of very short duration to flow through the counter.

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F. P. Kokesh, a native of Hopkins, Minn., since January 1950 has been division engineer in Mississippi for Schlumberger Well Surveying Corp. A graduate of University of Minnesota in 1935 with a bachelor degree in electrical engineering, he joined Schlumberger at Shreveport in December 1937. Kokesh served with the U. S. Army Signal Corps and U. S. Air Corps as a lieutenant colonel from 1941-45. He rejoined Schlumberger in November 1945, and served as district engineer at Winnfield, Monroe, and Harvey, La., before being appointed to his present position.

This pulse can be transmitted up the cable to the recording equipment at the surface.

Efficiency of Counter

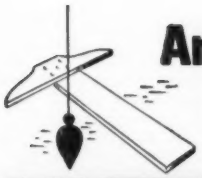
The simplest type of Geiger Muller counter has been described herein. If the counter were made in just this way, it would not be very efficient and would fail to count a large share of the gamma rays impinging upon it. By means of various refinements, the Geiger counter presently used in logging practice is capable of detecting a substantial share of the gamma rays impinging upon the device that are above a certain energy level.

Effect of Size and Shape of Counter

If the Geiger counter will react to gamma rays hitting it, then it becomes obvious that the larger the counter is, the more gamma rays it will intercept and the more sensitive the instrument will be. We must keep in mind that the gamma rays generated by the formations surrounding the bore hole are flying about in all directions and that some of them cross the bore hole where they may encounter the gamma-ray detector. The larger the counter is, the more rays it will intercept. There are, however, some very definite limitations on the size in which the Geiger counter can be made.

Obviously the diameter of the Geiger counter must be limited to such a dimension as can be lowered safely into holes that are cased with 5-in. pipe or even smaller. This limits the diameter of the counter itself to some 2 or 3 in. The length of the counter is not quite so seriously limited, and for this reason counters are made several feet long.

The Geiger counter presently used is 2 to 4 ft. in length. We do, of course, run into a practical limitation as far as length is concerned, because obviously a longer counter will tend to average out the variations in gam-



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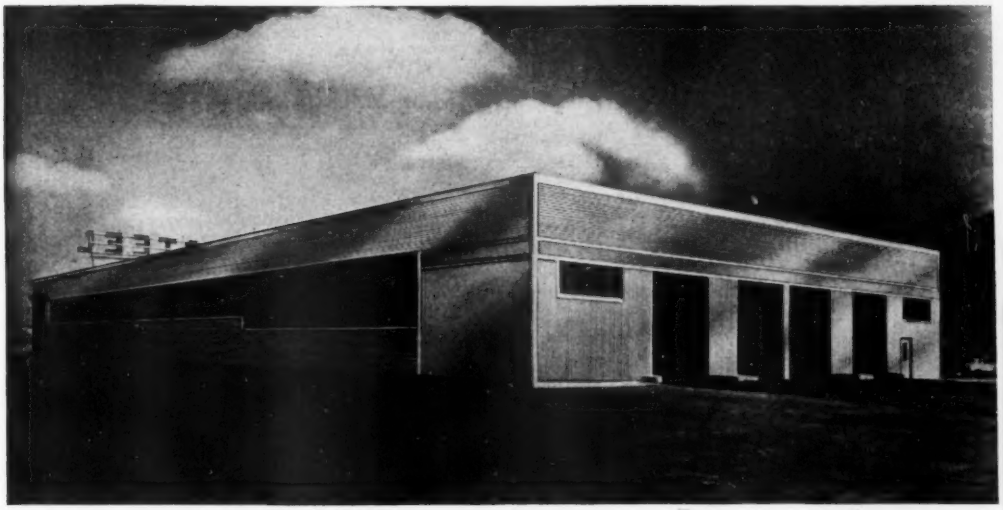

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ma-ray intensity along that part of the hole which is opposite the counter and there will be a reduction in detail; also the boundaries of the beds will be less clearly defined. It will be shown, however, that a gamma-ray counter 4 ft. long does a remarkably good job of locating thin beds and of picking bed boundaries. It does a much better job than one might expect, considering its length, and also considering the fact that gamma-ray logs are generally compared with the self-potential log which is recorded with an electrode of very short length.

Statistical Nature of Gamma Rays

We now come to a discussion of a gamma-ray characteristic which is the greatest handicap standing in the way of making perfect gamma-ray logs and this is the fact that the gamma rays emitted by the formations do not pour out in a continuous stream, but their number at any particular point varies from one instant to another. We can say that the number of gamma rays passing any point per unit time is statistical in nature. However, if we take the count for a sufficiently long period of time, we obtain an average which is very close to the true average intensity of that particular formation at that point. The length of time required to obtain this average is appreciable, being of the order of several seconds.

The statistical nature of the gamma rays would not be such a handicap if it were not for the fact that the total number of gamma rays traversing any part of a drill hole is quite limited. Even the number intercepted by a counter 4 ft. long and 2 or 3 ft. in diameter, may be of the order of only several hundred per second. The Geiger counter reacts to these gamma rays individually and there are, therefore, sent to the surface recording equipment, electrical pulses which are of about the same number per second as the rate of interceptions of gamma rays by the Geiger counter.

Smoothing of the Statistical Variations

If this varying number of pulses were to be impressed directly on a recording galvanometer, that galvanometer would try to follow the variations in counts per unit time and a very rough-appearing log would result. In order to smooth out the statistical variations, the electrical impulses received at the surface are impressed on a condenser, the charge on which increases as more pulses are impressed upon it. The potential across the condenser will likewise increase and this potential can then be placed on the recording galvanometer. The condenser is also at all times trying to discharge through a resistance and, therefore, the potential across the condenser will assume a value which is dependent on the average rate at which the impulses are impressed upon it.

Time Constant

As soon as we introduce the condenser into the circuit, however, we introduce a lag in the recording equipment. If we take our Geiger counter from a point in the hole where the intensity is of a certain amount and move it to a point where the intensity is of a different amount, the recording apparatus at the surface will not react immediately, and theoretically, it will never reach the reading corresponding to the new point. Practically, it will reach a substantial share of the new reading within a few seconds. The charge on the condenser will, in such a case, vary with time and the charge can be expressed by the equation:

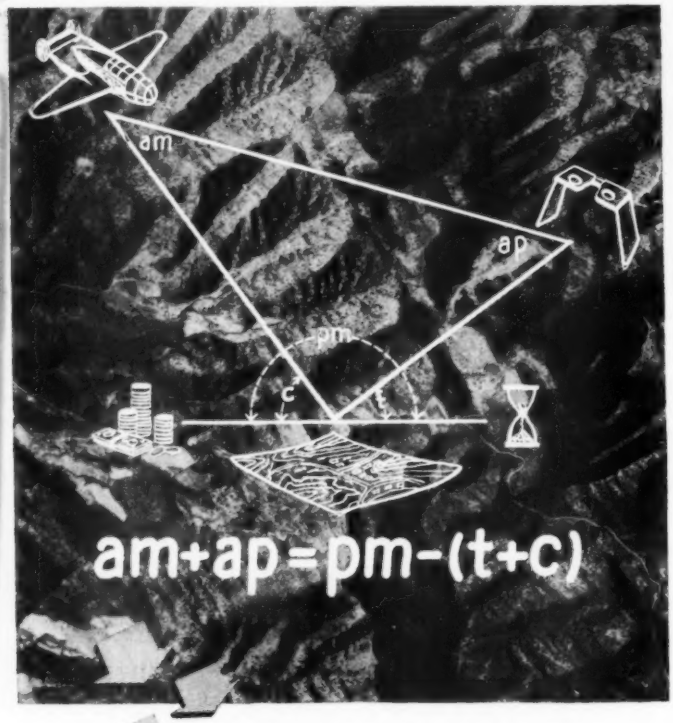
$$Q = 100\ (1 - e)\ (-\ t/RC)$$

Where

Q = Charge on condenser
e = Logarithmic base
t = Time in seconds
R = Resistance in circuit
C = Capacitance

The constant 100 is introduced so that all calculations will be on a percentage basis. In the theoretical discussion which follows, 100 per cent reading is arbitrarily assumed for sand and zero per cent for shale.

The particular time "t" that is equal to the product of R and C, is known



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as the time constant of the circuit and in this time, for any given change of intensity, 63 per cent of the change takes place at the recorder.

Fig. 2 shows a theoretical gamma-ray intensity anomaly which is represented by the dashed lines. This anomaly at a speed of 720 ft. per shape and it might be assumed to exist opposite a sand body.* If we go from an intensity at point "A" to a different intensity at point "B," the change on the condenser and recording galvanometer will follow the equation shown above.

If we come up logging past this anomaly at a speed of 720 ft. per hour, and if the time constant for the system is 7 seconds, then the response of the recording equipment will be such that when 7 seconds have elapsed after crossing the boundary, we will have obtained 63 per cent of the deflection. From that time on the apparatus will react at a slower and slower rate but within some 30 or 40 seconds it will have reached very nearly the maximum value. This, then, is the effect of the time constant, the value of which is shown on every Schlumberger gamma-ray log heading. This curve is plotted for a speed of 720 ft. per hour and a time constant of 7 seconds. It will be noted that 63 per cent of the anomaly is obtained when the counter has moved a little more than 1 ft. We must keep in mind that this curve is based on a counter which is very short in length and that it is not a practical curve such as would be obtained with a counter 4 ft. long.

When we pass the top of the anomaly the reverse happens. The apparatus responds rather rapidly just after we pass the boundary and 63 per cent of the anomaly is lost after a period of 7 seconds. Thereafter, the anomaly drops off a slower rate. The net result is that the anomaly is distorted, particularly at the outer zone on the lower contact and at the inner zone of the upper contact, and there is an apparent shift of the anomaly upward on the log. If we take the halfway point, we can see that the shift is about 1 ft. In other words, we should make a plus 1 ft. correction in our measurements when we log with this theoretical system.

The theoretical curve shown is smooth and shows no statistical variations. Removing all of the statistical variations would require too great a time constant, and the circuit elements are therefore designed to hold the variations to 5 per cent of the full reading of the scale used. If the anomalies along the bore hole are large, the figure of 5 per cent will apply. For small anomalies, the statistical variations may, of course, assume a much larger proportion.

*Throughout this paper "increasing" anomalies are assumed opposite sands regardless of the direction of increasing radioactivity. This is done because one normally associates anomalies with sands rather than with shales.

Effect of Counter Length

In practical logging, we must use a counter of appreciable length, and the one we use is 4 ft. long. If we were to take the same theoretical anomaly, which is shown on Fig. 3, and move by it with a counter that is 4 ft. long, but which somehow can be made to operate with a time constant of zero, we would get a curve which should be an average of the intensity along the hole at all times. Obviously, if the counter is 4 ft. long, its point of measurement is 2 ft. down from the top and when its upper extremity reaches the lower boundary it will start to react.

When the point of measurement of the counter is opposite the contact between the formations, it will read half the maximum value and it will reach the maximum value when the entire counter has entered the formation. Likewise, at the top of the bed, the reading will start to drop off when the upper end of the counter leaves the top of the bed and the reading drops to zero when the lower end of the counter emerges, which would be 2 ft. above the top. We then obtain a symmetrical trapezoidal anomaly, the trapezoidal effect being caused by the finite length of the counter. Here again we have an impractical system because we cannot build a practical circuit which will give us a zero time constant.

Time Constant and Long Counter Combined

It might appear that with the two distorting effects of the time constant and the counter length, the picking of the boundary would be complicated, but there is no need for serious concern because the situation is really not so bad, as is demonstrated on Fig. 4. Shown here again is the theoretical rectangular gamma-ray intensity anomaly. On it has been drawn in solid lines the shapes of the curve we would obtain with a counter very short in length and with a time constant of 7, and also with a 4-ft. counter and zero time constant. These are the same curves that were presented on the previous drawings (Figs. 2 and 3).

When the curve obtained at 720 ft. per hour with a counter 4 ft. long and a time constant of 7 is computed and added to the diagram, we have the curve shown by the long dashed line. It is seen that this curve does not depart very much from the curve obtained with a counter of very short length. True enough, reaction starts about 2 ft. below the lower boundary

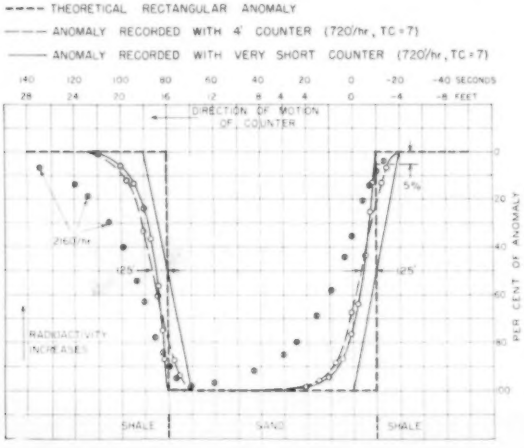
THEORETICAL RECTANGULAR ANOMALY
ANOMALY RECORDED WITH 4' COUNTER (720/hr, TC = 7)
ANOMALY RECORDED WITH VERY SHORT COUNTER (720/hr, TC = 7)
140 120 100 80 60 40 20 0 -20 -40 SECONDS
28 24 20 16 12 8 4 4 0 -4 -8 FEET
DIRECTION OF MOTION OF COUNTER
5%
720/hr
25'
25'
RADIOACTIVITY INCREASES
PER CENT OF ANOMALY
SHALE
SAND
SHALE

Fig. 4—Combined effect of counter length and time constant.

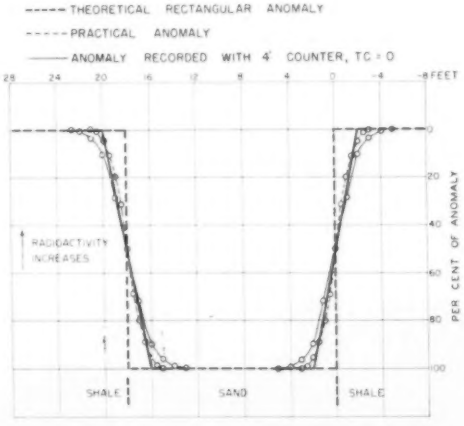

Fig. 5—Effect of rounding of practical gamma-ray anomaly.

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of the bed, but when the midpoint of the anomaly is reached, the two curves are fairly close together and as the anomaly tapers off, it follows the zero counter length anomaly very closely. Likewise, as we approach the top of the bed, the curve starts to drop a couple of feet before the top of the bed is reached, but the reading is again very close to that of the zero counter length anomaly at the halfway point. We have here now a picture of a practical recorded gamma-ray anomaly.

If we measure the displacement of the halfway point of the recorded anomaly from the halfway point on the theoretical anomaly, we find that this displacement is 1.25 ft. In other words, the fact that the counter is 4 ft. long has made only about 0.25 ft. increase in lag. At the same time, the shape of the curve is not substantially altered. It was stated above that the reaction starts 2 ft. before the boundary is reached.

Actually, only about 5 per cent of the total anomaly takes place in the first foot. Since the equipment is made up in such a way that it allows statistical variations of about 5 per cent of the scale used, it follows that 1 ft. of this lead is obscured by the statistical variation that remains in the log and we might then say that the anomaly starts 1 ft. below the boundary in the cost of large anomalies. Likewise, at the top, the anomaly starts 2 ft. too soon, but 1 ft. of that is again lost among the statistical variations and we say that the curve actually appears to start dropping when the point of measurement is just 1 ft. below the top of the bed. To this 1 ft would have to be added the 1¼-ft. correction allowed at the halfway point, making the point of departure about 2 ft. ahead of the actual boundary. In the case of small anomalies, the statistical variations may obscure the top and bottom to a much greater extent.

Actual Gamma-Ray Anomalies

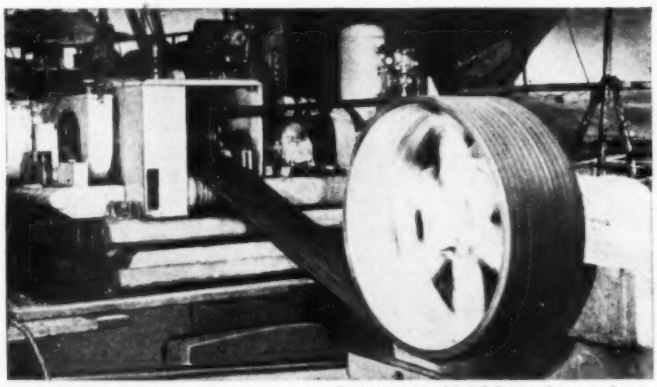
Up to this point we have been talking about theoretical gamma-ray anomalies which are rectangular in shape. Obviously, such a retangular anomaly, with square corners, could not exist in nature. There is bound to be a fringing or averaging effect at the edges. Fig. 5 shows a sand body with shale above and below. Also shown is the theoretical rectangular anomaly. The actual distribution of gamma-ray intensity is not a rectangle, but it is a symmetrical rounded anomaly which is shown by the very short dashed line.

The curve has been derived on the basis that gamma rays can penetrate about 3 ft. of formation and that their intensity varies approximately inversely with the square of the distance from the source of the gamma rays. Therefore, when we reach a point 3 ft. from the sand, we will start to lose some gamma rays to that sand and as we approach closer, the intensity decreases more rapidly. When we are at the contact between the shale and the sand, we should have 50 per cent of the deflection we have opposite the sand itself. As we pass the boundary, the intensity will decrease until we have penetrated 3 ft. into the sand.

From that point on, the intensity should be the same until we reach a point 3 ft. below the top where the intensity will begin to increase because we are now approaching a bed of shale which has a higher intensity than the sand and some of the gamma rays from the shale penetrate the sand. The decay of the anomaly will be symmetrical with its buildup. The rounding out of the rectangular gamma-ray anomaly is roughly of the same order as the rounding of the S.P. curve obtained in South Louisiana formations which have about 1 to 2 ohms resistivity. The effect seems to be greater on the drawing because the vertical scale has been purposely increased so as to make the rounding more obvious.

Effect of Rounding of Actual Gamma-Ray Anomalies

Here again we might think that the rounding of the anomaly at the boundaries will have a disastrous



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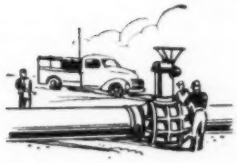

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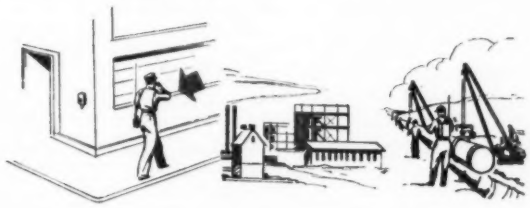

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effect on the shape of the final recorded curve and that it may seriously interfere with our picking the tops and the bottoms of the sands. If we calculate and plot the curve obtained by going past such a rounded anomaly with a counter 4 ft. long and with a zero time constant, we obtain the anomaly shown by the solid line in Fig. 4. Shown also is the trapezoidal anomaly obtained opposite a theorectical rectangular anomaly with a counter 4 ft. long and with zero time constant.

It is seen that all the curves fall very close together and, therefore, the effect of rounding of anomaly edges is really not at all serious. It has no effect whatsoever at the midpoint of the anomaly at which point we generally pick the top and bottom of the formation. At the most, it may increase the takeoff point of the curve by perhaps 0.25 ft., because most of the rounding effect is within the 5 per cent range of the statistical variation of the final gamma-ray log.

The curve that would be obtained with a 4-ft. counter, a time constant of 7 seconds, at a speed of 720 ft. per hour would, of course, be displaced upward and distorted almost exactly as represented on Fig. 4. Finally, the anomaly, taken at the the halfway of the deflection, is shifted 1.25 ft. upward with respect to the actual location of the bed. The above discussion disregards the presence of the bore hole and the sensitivity pattern of the counter, both of which tend to reduce the effect of rounded anomalies and thus the 0.25-ft. correction may be disregarded.

Thin Beds

Returning then to the practical recorded anomaly which was shown on the previous diagram (Fig. 4), we have the shape of the curve we would obtain in a thick bed. As was stated before, there is a tendency for the anomaly to be shifted upward and we must make a 1.25-ft. correction downward in order to get the apparent anomaly at the correct depth.

The next question that arises is "what will happen in a thin bed?" Obviously, if the bed is sufficiently thin, the upper end of the 4-ft. Geiger counter will emerge from the top of the bed before the lower end of the counter has entered into that bed. If the time constant could be zero, all beds less than 4 ft. thick would be affected in this manner. However, because of the delaying action of the practical time constant, beds somewhat thicker than 4 ft. will show the same effect.

If we imagine the upper half of the anomaly in Fig. 5 to be brought down closer and closer to the lower half, we would find that we have a substantially symmetrical anomaly on top and bottom as the bed is 5 ft. thick or less. We would, of course, still have to carry that 1.25 ft. of depth correction, but for beds thinner than 5 ft., the peak of the gamma-ray curve would correspond to the peak on the self-potential curve. This makes correlation of the electrical log and gamma-ray log by means of the peaks on the thin beds very reliable and convenient, sometimes more so than correlating on the tops and bottoms of thick beds.

Length of Base of Anomaly

While the peak on the gamma-ray curve would correspond to the center of a thin bed, the base of the gamma-ray anomaly would be appreciably broader than the bed is thick. This increase in the length of the base of the anomaly is caused by the counter length and the time constant, and amounts to about 5 ft. with a 4-ft. counter, a time constant of 7 seconds, and a logging speed of 720 ft. per hour.

Reducing Length of Counter

As was mentioned before, the counter, because of its appreciable length, tends to average out the variations of gamma-ray anomalies along the hole and beds less than 7 or 8 ft. thick will fall short of registering their true intensity. The thinner the bed, the smaller the peak will be. Likewise, if the counter lies opposite a series of thin beds, only 1 or 2 ft. thick, the variations of intensity will be seriously reduced and even lost altogether in the statistical variations.

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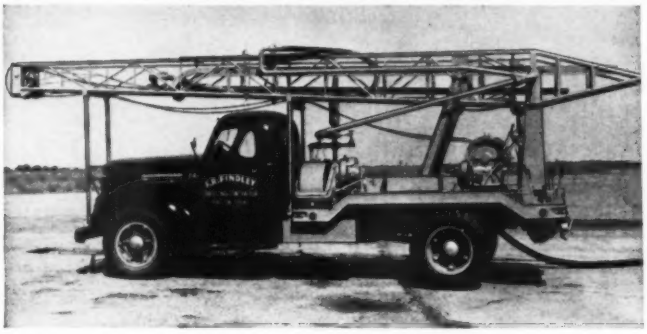

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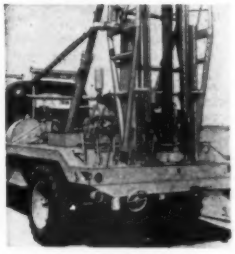

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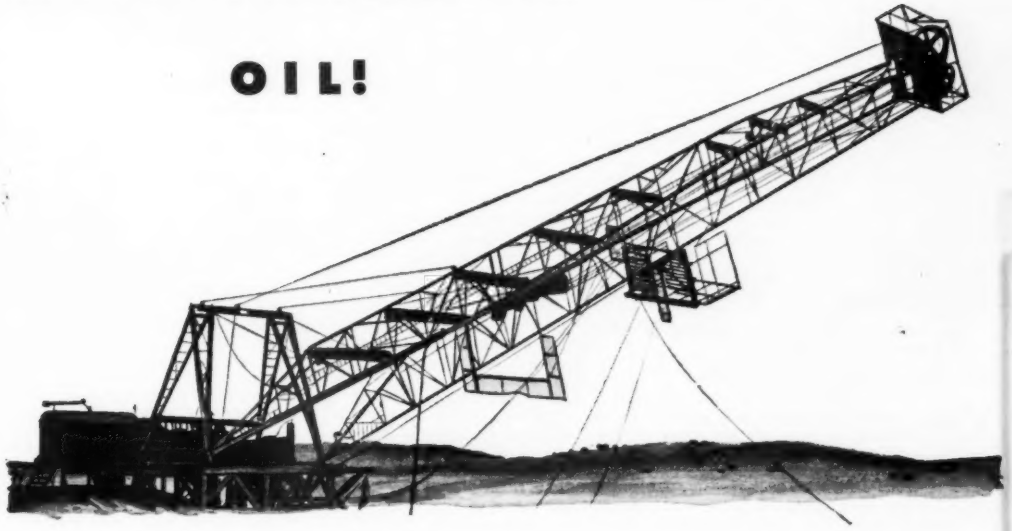

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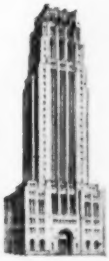

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we could reduce the length of the counter because we would then get a sharper break at the top and bottom of the bed and we could record the detail existing in thin beds. However, we can use a shorter counter only if we, at the same time, reduce the time constant. It would do us no good to cut the counter in half, if the time constant were to remain the same, because for a time constant of say 7, the Geiger counter must move at least a foot before it reacts sufficiently to a change in gamma-ray intensity and we would, therefore, lose the variations whose period is equivalent to about 1 ft.

If we reduce the counter length, we effectively reduce the sensitivity. If we reduce the sensitiviy, we must increase the time constant if we wish to get a log that is reasonably free of the effects of the statistical variation. The reduction in length of the counter and reduction of the time constant are two strongly opposing requirements in the design of gamma-ray logging equipment.

General Level of Gamma-Ray Activity

This problem is more serious in the Gulf Coast than in certain other areas, because in the Gulf Coast the general level of radioactivity is comparatively low and we must therefore use a high sensitivity.

In West Texas, however, the general level of radioactivity is much higher and a lower sensitivity can be used. In that event, it may be possible to reduce the length of the counter and maintain the same time constant, and still get a good log.

Effect of Speed

There is one important factor that has not so far been touched upon in gamma-ray logging and that is speed of logging. This problem revolves, of course, about the matter of the time constant. If we increase the speed, the effect of the time constant obviously will be to round out the anomalies more and more. The effect of the increase in speed would be an apparent delay on the part of the equipment to react to a change in gamma-ray intensity.

The practical anomaly shown by the solid black line (Fig. 4) is drawn on the basis of a recording speed of 720 ft. per hour and this bed which is 18 ft. thick shows up fairly well without any really serious distortion. However, if we increase the speed three times, in other words, to about 2,160 ft. per hour, we would obtain an entirely different curve. That curve has been indicated on Fig. 4 by means of the small crossed circles. It is seen that in spite of the fact that the bed is 18 ft. thick, the curve just barely approaches the maximum value before it must start back down again. The slope of the sides of the anomaly is about one-third as great, as might be expected. In addition, the apparent displacement of the entire anomaly is about three times as great, being very nearly 3 ft. at the midpoint of the anomaly. It is obvious from this that in South Louisiana we cannot make practical detail logs with a time constant of 7 seconds and a speed of 2,160 ft. per hour. It is possible to use a greater speed in those areas such as West Texas where the level of the gamma-ray intensity is high enough so that a time constant of 3 seconds can be used.

Actual Examples of Gamma-Ray Logs

A number of actual gamma-ray logs are presented which will illustrate most of the theoretical points brought up so far. These examples all have been drawn to take into account the correction for lag of the point of measurement on the Geiger counter.

Time constant effect. — Looking first at Fig. 6 (Golden Meadow, La.), we find illustrations of the distorting effects of the time constant and the length of the counter at the well defined contacts between sand and shale. This log was recorded in open hole and the self-potential was recorded along with the gamma ray. The difference in point of measurement of the self-potential and the gamma ray was known accurately. The self-potential was recorded at the correct depth and after the log was made, the gamma-ray part was cut off and slipped downward the necessary amount, including correction for lag, so that the anomalies on both the gamma ray and the self-

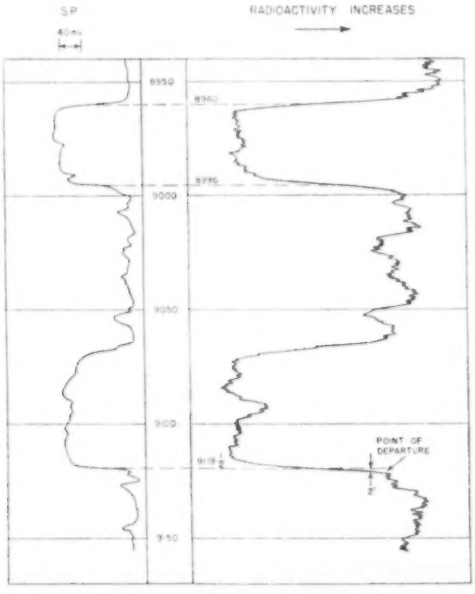

Fig. 6—Self-potential and gamma-ray anomalies. Time constant, 7; speed, 720 ft. per hour.

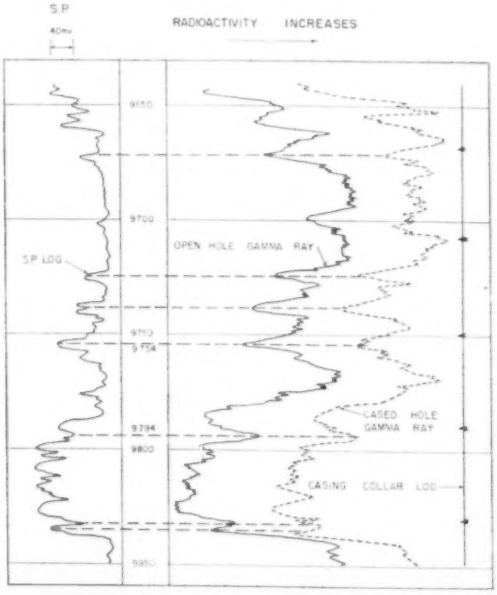

Fig. 7—Natural radioactive markers. Time constant of 7 and speed of 720 ft. per hour.

This 1943 Article is even more important *today!*

August 9, 194

THE OIL WEEKLY

Accurate Depth Measurements Vital to Well Completions

The oil industry can no longer afford the luxury of careless depth measurements, with manpower and material at a premium. Accuracy and correlation of measurements must be maintained "from the grass roots down."

By A. C. H. COOKE
Division Engineer, Lane-Wells Company

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Seems a little like 1943, right now — similar demands for production, similar possibilities of manpower and material shortages. And with today's even greater demands and deeper wells, the best possible completions are even more vital now.

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potential are at the correct depth, permitting direct correlation across the log.

At 9,119.5 ft. we find a very sharp contact between shale and sand, according to the S.P. log. When we examine the gamma-ray log, we find that the excursion of the gamma-ray curve is very rapid at first and that it rounds off as the maximum anomaly is approached. We have a similar example at 8,996 ft. On the same log we have a good illustration at 8,960 ft. of the sharp break of the gamma-ray curve which occurs as we pass the top of the bed. The curve drops off very rapidly at first and then rounds off as the minimum anomaly is approached.

Effect of counter length.—Looking again at the lower boundary of the anomaly, at 9,119.5 ft. on the S.P., we find that the gamma-ray anomaly takes off at about 9,121.5 ft. This is the 2-ft. difference which is to be expected from the length of the 4-ft. counter and the necessity of correcting 1 ft. for lag. If we measure the width of the gamma-ray anomaly at its base, we find that almost invariably it is exactly 5 ft. greater than the thickness of the sand as indicated by the S.P. log. The S.P. anomalies are, of course, somewhat broadened themselves, but not quite so much as the gamma-ray anomalies.

Symmetry on thin and thick beds.—In Fig. 7 (Golden Meadow, La.), we have good illustrations of the symmetrical peaks obtained on thin beds. Note the excellent straight-across correlations obtained on the thin beds at 9,754 and 9,794 ft. In some cases there is a foot or so difference in the depth of the exact peak, this being caused by distortion resulting from the statistical variations on the gamma-ray log.

On another part of this same log, Fig. 7, we have illustrations of the distortion appearing on thicker beds. On any of these thicker beds we see here, if we were to to take the outer part of the anomaly only, we might be inclined to say that the gamma ray is shallow in respect to the S.P. curve. This is because the lower half of each anomaly at the lower boundary of a bed is rounded upward and the upper half of the anomaly at the top of the bed is also rounded upward. The apparent effect is to give a shift of the entire gamma-ray log upward and one must be very careful to do the correlating at the lower boundary of the midpoint of gamma-ray anomalies.

Effect of speed.—Fig. 8 shows another gamma-ray log (Bayou Perot, La.) recorded in open hole along with S.P. The same section was recorded at speeds of 720 and 2,700 ft. per hour. Note the vast difference in the quality of these two logs. In particular, note how much more the base of the sand is rounded at 8,950 ft. on the 2,700-ft. per hour log. Note also that the sand at 8,740 ft. shows up much less clearly and sharply than it does on the 720 ft. per hour log. It is obvious that we must record slowly if we wish to obtain good logs.

Use of Gamma Ray for Depth Control

One of the principal advantages of the gamma-ray log is that it can be made after the casing has been set in the well. If casing collars be recorded along with the gamma-ray log and if the gamma-ray log can be correlated with the electrical logs, then one can accurately locate formations behind the casing by referring them to the casing collars. This practice is well known in the oil industry.

Natural Radioactive Markers

It is found, however, that sometimes it is rather difficult to obtain a perfect correlation between the self-potential curve and the gamma-ray curve recorded in cased holes, and one has a choice of correlating the logs several feet one way or the other. If the well is to be completed in a thin sand, a wrong correlation could be disastrous. There is a way of getting around this difficulty and that is the use of natural radioactive markers.

Coming back to Fig. 7 we have a self-potential log and a gamma-ray log recorded at the same time in open hole. Since we know the relation of the points of measurements of the gamma ray and the self-potential, we know definitely what their correlation is, even though the gamma-ray log does not always resemble the self-potential log very closely.

If, after casing is set, another gamma-ray log is made, (shown on Fig. 7 by a dashed line) we can superimpose the two gamma-ray logs and we have then accurately bridged the gap between the self-potential curve and the casing-collar log (also shown on Fig. 7) which is recorded along with the gamma-ray log in the cased hole. Reproduction of the gamma-ray log in the cased hole is remarkably good in this case, but even if it were not quite so good, correlation between the two would be unmistakable; much more so, perhaps, than direct correlation between the gamma ray and a self-potential log. This technique makes use of the natural radioactive markers which exist in every well in the form of gamma-ray anomalies.

Fig. 9 shows a gamma-ray survey and an electrical survey made in a well (Bay Marchand, La.) in which a salt-water flow was encountered. It was impossible to bring this salt-water flow under control and the S.P. curve obtained in the well was very

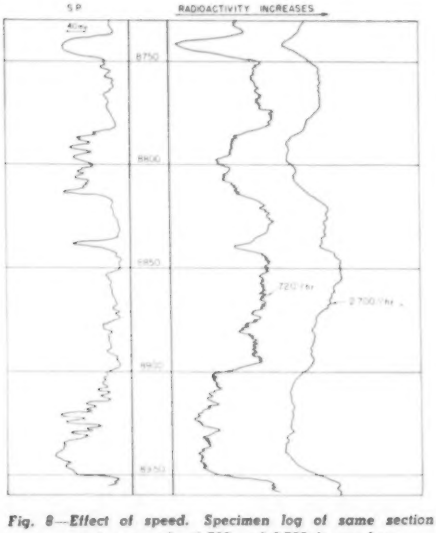

Fig. 8—Effect of speed. Specimen log of same section recorded at speeds of 720 and 2,700 ft. per hour.

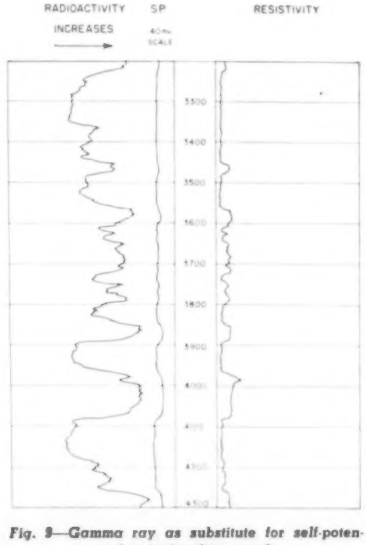

Fig. 9—Gamma ray as substitute for self-potential in high salinity mud.

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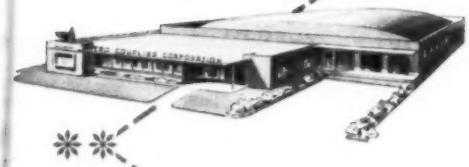

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poor because of extremely high salinity of the mud. It is, in fact, almost impossible to distinguish the sands on the S.P. side of the log, although one might infer where the sands are from the resistivity curve. A gamma-ray log was run in the open hole in this case and when the two logs are matched according to depth, it is evident that the gamma-ray curve acts as a very good substitute for the S.P. Note that in every case where there is a decrease in resistivity, indicating a salt-water sand, there is a sand type anomaly on the gamma-ray log. By using this gamma-ray log in place of the S.P., the oil company was able to correlate with other electrical logs in the same field with complete success. Of course, this might not always be possible, but it does so happen in this field that the sands and shales are clearly and reliably defined on the gamma-ray log.

Correlation of Gamma Ray and Resistivity Curves

Ordinarily the gamma-ray log is correlated with the S.P. curve. Frequently good correlations can be made in the absence of S.P. anomalies by using the resistivity curves. In general, best results are obtained by reversing the resistivity curves. Lime and lignite beds, for example, are then represented by anomalies to the left, the same direction in which the gamma-ray log usually reacts. It is also found that even in relatively uniform shale sections, correlation points can frequently be found on the reversed amplified normal curve. No attempt is made here to illustrate such correlation inasmuch as there is seldom a series of such points and one must look for them on the individual log to confirm the correlation arrived at by using the principal anomalies.

Conclusion

The effect of Geiger-counter length, time constant, and recording speed on the gamma-ray log can be derived quite easily by breaking down the log into its various components.

It has been shown that a counter 4 ft. in length does a remarkably good job of indicating bed boundaries and picking up thin beds, provided a fairly low speed of logging is used.

Reducing counter length and reducing the time constant are opposing factors in the design of gamma-ray logging equipment.

Gamma-ray anomalies existing in all bore holes can be used as natural radioactive markers to obtain precise depth control by recording S.P. and gamma-ray logs simultaneously in open hole, and then recording the gamma ray along with casing collars in cased holes. Perfectly reliable correlation is then obtained between the electrical log and gamma ray. Where an S.P. log cannot be obtained, the gamma-ray log may act as an excellent substitute.

Well Spacing

. . . from a geologist's viewpoint

ENGINEERING Reference Section

by John G. Bartram*

WELL spacing in oil pools is an important problem, but not as all-important as some contend. It is only one part, and not even the most important part of the complicated problem of recovering oil from underground reservoirs. Much more important than well spacing is the proper use of all available energy, whether natural in the reservoir or added, to displace oil from the rock and move it into the wells. The proper use of energy can be obtained only by controlling the rate at which oil is withdrawn from an entire reservoir. Excessive withdrawal rates waste energy. Unfortunately, the intense arguments on the question, what is the correct well spacing for each new pool, have distracted attention from the more important question, what is the proper rate of oil withdrawal for each new pool?

The oil industry through years of research and practical experience has learned much about the behavior of oil, gas, and water in underground reservoirs. It is known that there are four sources of energy in oil reservoirs, and that in any one there can be any combination of the four.

1. Expansion of the gas dissolved in the oil and liberated as the pressure declines, generally called depletion-type reservoir.

2. Expansion of free gas in either an original gas cap, or in a gas cap formed during the production of a field.

3. Water drive, generally due to hydrostatic head in a water-bearing formation that is continuous to points of water intake.

4. Gravity, which alone usually operates slowly under oil-field conditions, but supplements the effects of the other kinds of energy.

There is now general agreement that an efficient water-drive, such as in East Texas field, will recover 70 per cent or more of the original oil, if oil withdrawal is controlled to an efficient rate, as is done at East Texas. Proper use of the energy in an expanding gas cap will permit recoveries up to 35 per cent of the original oil. To save gas-cap energy, as well as the gas itself, the waste of such gas by flaring is generally prohibited and gas-oil ratios are controlled. In depletion-type pools, where the only sources of energy are the expansion of gas coming out of solution and the force of gravity, recoveries are lower, only 15 to 25 per cent of the original oil, unless additional energy is supplied by fluid injection.

The great problem of the oil-producing industry is to increase these recovery percentages wherever possible. There is disagreement on how to increase them. One group in the industry says that more oil can be recovered if each pool is scientifically studied as a geological and engineering unit and then developed and operated according to a complete program. This would efficiently and economically use the available energy, and, if necessary and practical, provide additional water-drive or gas-drive energy from outside sources. It would require control of the oil-withdrawal rate. The number and spacing of wells would be planned to meet, but not exceed the designated oil-withdrawal rate of the pool, and to adequately drain all the reservoir, or reservoirs. All the recoverable oil would be obtained in one program, rather than in a primary program followed by a secondary program. Such a program can recover more oil, and in many fields in a shorter time, especially if additional water or gas-drive energy is provided.

Another group in the industry says that increased, or even proper, oil recoveries can be obtained only if the wells are located at relatively short intervals in close spacing patterns. They believe that the horizontal distance between well holes in a reservoir is a very important controlling factor. They admit the benefits of natural water drive and gas-cap drive, and of fluid injection into reservoirs to provide additional energy, but they insist much better recoveries can be obtained only with close well spacing.

The two groups disagree primarily because they have different ideas about the mechanics of oil movement in underground reservoirs. Their ideas are different because one group has an engineering background, based on physics and mathematics, and the other has a largely geologic background. The engineering group presents newer information and newer theories. The other group holds to older theories that were formerly generally accepted. If each group became more familiar with the other's science, the argument would diminish greatly.

Bases for Old Ideas

Historically, geologists entered the oil-producing business first and for some years handled all the petroleum engineering, including well spacing. During those earlier years, about 1910 to 1925, certain theories about reservoir behavior were developed, widely publicized, and generally accepted. Among these was the concept that a large proportion of the available reservoir energy was used in moving oil horizontally through the rock into the bottom of the wells. Hence, if the distance between wells were shortened, the available energy would force more oil into the wells, or if the distance between wells were increased more oil would remain unrecovered in the ground.

The ideas that many developed about reservoir mechanics were influenced by discussions of "Jamin action" and "Cutler's rule," both of which appeared to show that much energy was required to move oil through reservoir rocks. Jamin action is the name given to the following physical phenomenon: in a restricted tube, the surface tension on gas bubbles mixed with oil or water requires greater energy to move the fluid than is required if the same fluid contains no gas bubbles.

Since there are gas bubbles mixed with oil and water in most oil pools, the impression was created that Jamin action hampered the movement of oil in the reservoir rocks. However, Jamin action occurs only in restricted tubes, and oil sands are not restricted tubes. Many laboratory tests and core analyses show that in oil sands the pore openings are connected in all directions and that if a gas bubble blocks movement of oil in one direction, the oil can still

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Cutler's rule, advanced by a U. S. Bureau of Mines engineer, indicated that close-spaced wells produced more oil than wide-spaced wells, and that the differences could be calculated mathematically. Cutler's conclusions were based on early, unprorated fields, in which all wells flowed and pumped to maximum capacities and no effort was made to conserve energy by restriction of production. It is obvious that all wells producing wide open, and with differences in the well spacing, four wells on one 40-acre lease would produce more oil than one well on an adjacent 40-acre lease. Oil would migrate from the lease with one well to the lease with four wells. However, if well spacing in a field is uniform, there cannot be that kind of migration, whether the wells in the field are produced wide open or restricted under proration. It is not obvious why the advocates of close spacing believe that Cutler's rule proved that fields drilled on uniform close spacing will produce much more than similar fields drilled on wider spacing.

Modern Concepts

In the last 15 to 20 years, competent engineers and other scientists have used their physical and mathematical methods to analyze reservoir conditions and have learned that some of the earlier conceptions of reservoir mechanics were wrong. They have found that only a small part of the reservoir energy is used to move oil horizontally to the wells, and that large amounts of oil are not left in fields simply because the wells were too widely spaced. They now know that properly controlled use of available gas and water to displace and move the oil is by far the most important factor in increased recovery.

Two reservoir engineers, Callaway and Keller, in a recent paper, showed that the expenditure of energy for horizontal movement of oil in the reservoir is only a minor part of the whole recovery picture, and should not be considered alone. They calculated theoretical recoveries for different well spacings in pools where all other factors were equal. They figured two separate but identical 160-acre pools with continuous permeability of 15 md., sand thickness of 30 ft., 12.4 per cent porosity, 32°-gravity oil, 25 per cent connate water, shrinkage of 8 per cent, and 3,200,000 bbl. of oil in place.

They used a well abandonment rate of 3 bbl. per day. One 160-acre pool was produced from one well (160-acre spacing) and recovered 516,800 bbl. or 16.15 per cent of the original oil. The other 160-acre pool was produced from 16 wells (10-acre spacing) and recovered 531,200 bbl. of 16.60 per cent of the original oil. The drilling of 15 additional wells recovered only 14,400 more barrels of oil.

Of course, the pool with only one well would take a much longer time to produce the oil. If the two pools were both unprorated, it would take considerably longer. If both pools were prorated, the disparity in time would be greatly reduced. It is then simply an economic problem: How much more money should the operator spend for additional wells to recover the oil in a shorter period of time?

In these calculations, the engineers assumed continuous permeability in the reservoir rock. The producing horizons in many pools are reasonably uniform and permeable, but in many others the sandstones and limestones are irregular both in shape and permeability. In such fields, where discontinuity of the reservoir rock is demonstrated, everybody agrees that properly spaced wells must be drilled to drain separate parts of a reservoir, or, more correctly, separate reservoirs.

Argument Continues

When the engineers' theoretical and laboratory studies convinced them that the distance between wells was not the most important factor in oil recovery, they undertook to further prove it with statistical analyses of data from producing fields. Their opponents, who favored close spacing, made their own analysis, and also reanalyzed the engineers' figures. Many statistical papers were published on both sides of the question. However, the factors of oil recovery and physical conditions in oil fields are so irregular, that the effect of any one factor cannot often be determined.

Statistical analyses have not settled the question, and the argument continues. In the following paragraphs, some of the previous statistical analyses will be discussed and some new data presented. This will show that different investigators can draw opposite conclusions from essentially the same data, and that statistics can probably never settle the well-spacing problem.

In 1937, the American Petroleum Institute appointed a special committee on well spacing and allocation of production, which studied the problem for several years. In 1946, Craze and Buckley published an analysis of material collected by the committee. It included reservoir and production data on 103 numbered, but unidentified fields considered representative of average conditions in United States oil fields. The data were presented in two tables and part of their Table 1 is shown as Table 1.

Craze and Buckley made separate analyses of the 27 fields producing from sand with gas drive, and of the 70 fields producing from sand with water drive. They tried to determine quantitatively the extent to which well spacing might affect the ultimate oil recovery. They made corrections for differences in oil viscosity, pressure decline, and permeability. They concluded: "these field data show the ultimate oil recovery to be independent of the well spacing."

Later, Tomlinson, independently, studied the same A.P.I. figures and reached the opposite conclusion, namely, that the recovery of oil per acre-foot of producing sand was materially greater in close-spaced fields

TABLE 1—RESERVOIR AND PRODUCTION DATA

Study No.	Type of formation	Type of drive	Area of reservoir (acres)	Thickness of oil-producing formation (ft.)	Porosity (per cent)	Interstitial (connate) water (per cent)	Permeability (md.)	Depth of reservoir (ft.)	Reservoir temperature (°F.)	Initial reservoir pressure (psig.)	Current reservoir pressure (psig.)
1	Sand	Dissolved-gas	13,000	59	20	15	90	2,000	93	750	15
2	Sand	Water	1,600	10	30	35	1,000	6,600	158	2,950	2,880
3	Sand	Water	960	41	18	20	75	3,200	136	1,440	....
4	Lime	Water	4,400	20	Cavernous	....	....	3,540	90	....	....
5	Sand and lime	Gas	10,600	16.5	12.5	20	150	3,800	118	1,300	182
6	Sand	Water	135,076	35	25.22	17	2,000-3,000	3,700	146	1,620	1,015
7	Lime	Water gas-cap	20,000	100	Cavernous	20	Cavernous	1,000-1,800	82	700	521
8	Dolomite	Water	6,200	30	....	....	....	3,500	....	1,375	713
9	Lime	Water gas-cap	10,040	124	Cavernous	20	Cavernous	4,050-4,174	96	1,500	1,165
10	Sand	Water	4,250	17	32	30	50-5,000	3,500	134	1,980	1,925
11	Sand	Water	550	11.6	27.6	30	2,800	2,200	122	864	774
12	Sand	Dissolved-gas	280	43.5	15.3	40	6.8	2,100	109	....	25
13	Sand	Dissolved-gas water	1,868	20	28	30	264	4,850	165	1,900	1,245
14	Sand	Water	472	36	22	15	0-1,650	4,800	132	2,048	1,680
15	Sand	Dissolved-gas	24,913	43.3	17	35	125	2,900	120	1,165	45

than in wide-spaced fields. Tomlinson has presented his analysis orally at several meetings, but apparently has not yet put it in print. He presented it to the Petroleum Section of the American Institute of Mining and Metallurgical Engineers at San Antonio, Tex., in October 1949, and to the Research and Coordinating Committee of the Interstate Oil Compact Commission at French Lick, Ind., in August 1950.

Tomlinson elected to review the 70 water-drive sand pools used by Craze and Buckley. The number can be reduced to 66 or 64 by the elimination of apparent duplications. He further elected to consider only the 27 pools with depths between 2,500 and 5,000 ft. He divided these into two groups:

Eighteen pools with spacing less than 20 acres per well, average 5.54 acres; and nine pools with spacing more than 20 acres per well, average 25.98 acres.

He then calculated for each group the weighted average recovery of oil per acre-foot of producing sand. This was done by totaling the ultimate production figures for all the fields in each group, and dividing that total by the sum of all the acre-feet of producing sand in the same fields. This showed that the 18 close-spaced fields in the 2,500 to 5,000-ft. depth range will produce 900 bbl. per acre-foot, and the nine wide-spaced fields 457 bbl. per acre-foot.

He next divided these figures on recovery per acre-foot of pay sand by factors of pressure, obtained by dividing the average initial reservoir pressure of the fields by 1,000 lb. This method gave figures for estimated ultimate recoveries per acre-foot of pay sand per 1,000 lb. of reservoir pressure. The same calculation was made on all 66 sand water-drive fields, and the figures were larger for close-spaced fields than for wide-spaced ones. Tomlinson concluded from these analyses that the distance between wells is the most important factor in oil recovery.

Tomlinson's analyses have been publicly discussed by several engineers, including Buckley, Vietti, and Callaway, but their remarks have not yet been published. In some discussions, the point was made that different results would be obtained if Tomlinson had used arithmetic averages instead of weighted averages, and if he had used other depth ranges than the 2,500 to 5,000 ft. that he selected. It was pointed out that East Texas field is in the 2,500 to 5,000-ft. range and that its ultimate production of 5 billion barrels distorted his weighted average figure for close-spaced fields.

New Analyses

For this paper, new analyses have been made of the sand water-drive fields listed in the same A.P.I. data. Only 64 fields were used, since some of the original 70 were eliminated as apparent duplications. They have been divided into depth ranges of 0-2,500 ft.; 2,501-5,000 ft.; 5,001-7,500 ft.; and 7,501 to 10,000 ft.

In the following illustrations, the fields in each depth range are divided into a close-spaced group (less than 20 acres per well) and a wide-spaced group (more than 20 acres per well). The oil recoveries in barrels per acre-foot of pay sand are figured both as arithmetic averages and as weighted averages. The average well spacing, average per cent of porosity, and average per cent of connate water are shown.

In any analysis of oil recoveries per acre-foot of pay sand, it is obvious that the amount of pore space in the rock and the amount of connate or original water in the pore space are important factors that must be considered. A high per cent of porosity is favorable for larger oil recoveries, because there is more room in the rock for fluids. A low per cent of connate water is favorable because less of the pore space is full of water, and more is full of oil.

In the 0-2,500-ft. depth range, there are only seven fields listed, of which three were close spaced and four wide spaced (see Fig. 1). The figures on recoveries per acre-foot show that

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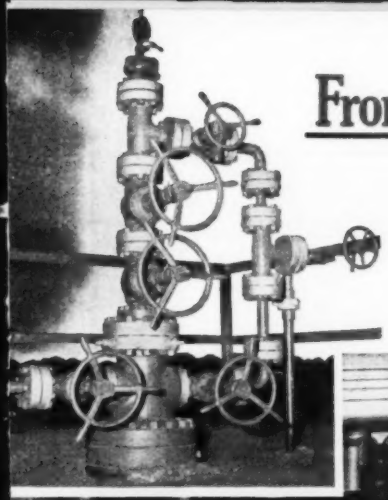

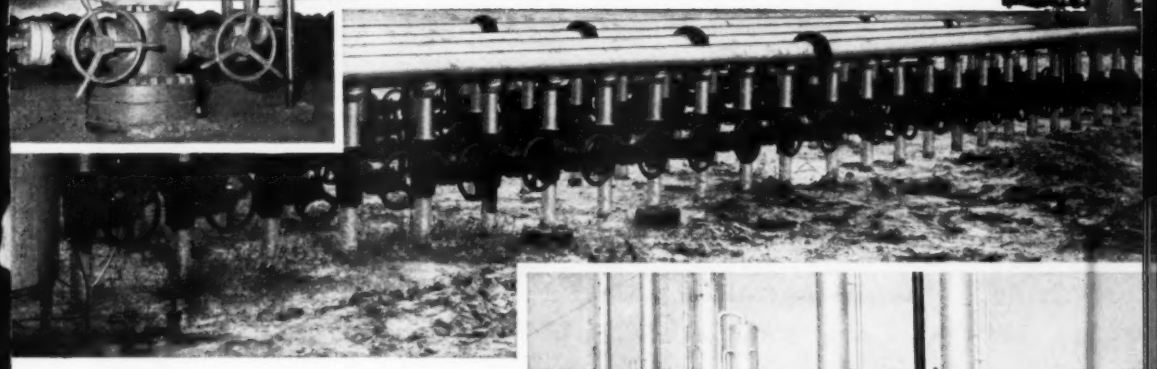

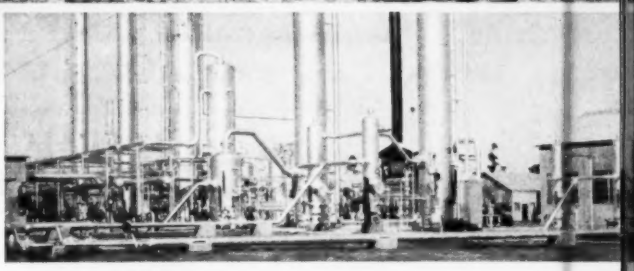

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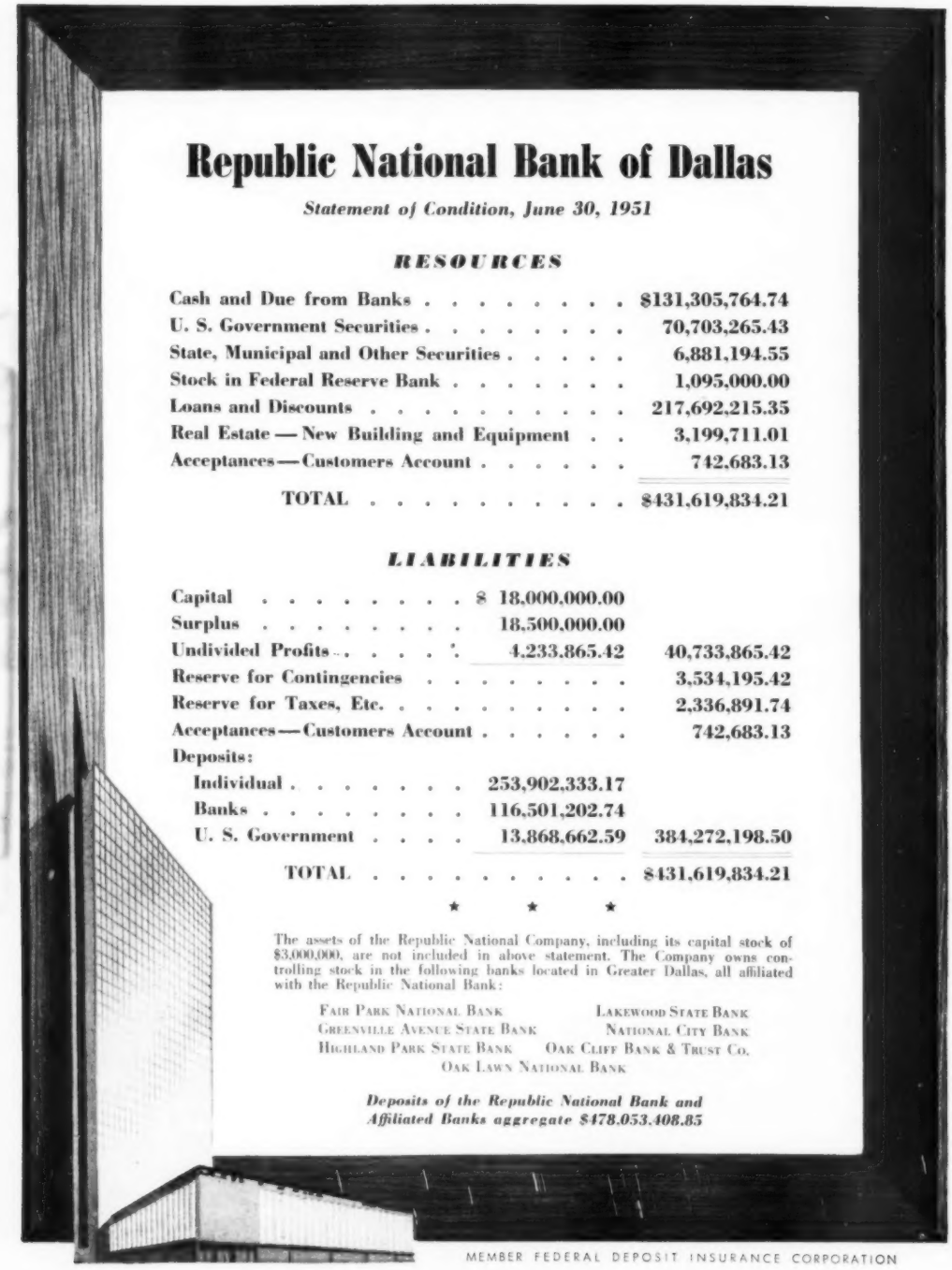

Republic National Bank of Dallas

Statement of Condition, June 30, 1951

RESOURCES

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U. S. Government Securities	70,703,265.43
State, Municipal and Other Securities	6,881,194.55
Stock in Federal Reserve Bank	1,095,000.00
Loans and Discounts	217,692,215.35
Real Estate — New Building and Equipment	3,199,711.01
Acceptances — Customers Account	742,683.13
TOTAL	$431,619,834.21

LIABILITIES

Capital	$ 18,000,000.00	
Surplus	18,500,000.00	
Undivided Profits	4,233,865.42	40,733,865.42
Reserve for Contingencies		3,534,195.42
Reserve for Taxes, Etc.		2,336,891.74
Acceptances — Customers Account		742,683.13
Deposits:		
Individual	253,902,333.17	
Banks	116,501,202.74	
U. S. Government	13,868,662.59	384,272,198.50
TOTAL		$431,619,834.21

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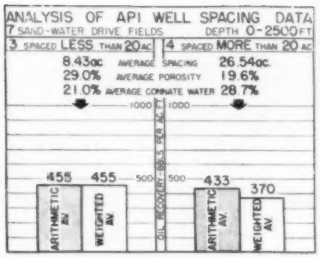

Fig. 1

the close-spaced fields are better both on the arithmetic and on the weighted averages. That certainly should be anticipated because the average porosity of the close-spaced fields is much greater (29.0 per cent to 19.6 per cent) and the connate water much less (21.0 per cent to 28.7 per cent).

In the 2,501-5,000-ft. depth range, there are 27 fields, of which 19 are close spaced and 8 wide spaced (see Fig. 2). This is the depth range that Tomlinson selected, and, as in his analysis, the weighted average is twice as high for the close-spaced group as for the wide-spaced group. This is partly due to the inclusion of the large East Texas field in the closed-spaced group, which distorts the weighted average. However, on the arithmetic average the close-spaced fields are higher, 637 to 486 bbl. per acre-foot. In this depth range also, the average porosity of the close-spaced fields is higher (25.5 per cent to 21.7 per cent), but the connate water is very little less (27.2 per cent to 27.4 per cent).

In the 5,001-7,500-ft. depth range, there are 26 fields, equally divided, 13 close spaced and 13 wide spaced (see Fig. 3). There is not much difference here in the recoveries, although the close-spaced fields are slightly higher. The weighted average figures show less spread than do the arithmetic averages. Again, the close-spaced fields have better porosity (28.3 per cent to 26.6 per cent) and less connate water (29.2 per cent to 31.7 per cent).

In depth range from 7,501-10,000 ft., which includes the deepest fields on the A.P.I. list, there are only four

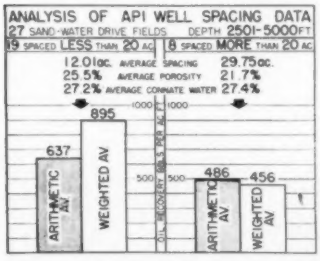

Fig. 2

fields, one of which is close spaced and three wide spaced (see Fig. 4). In this small group, the wide-spaced fields have much better recoveries than the one close-spaced field. That should not be surprising because the close-spaced field had less porosity (28.0 per cent to 30.8 per cent) and more connate water (40.0 per cent to 22.0 per cent).

Finally, all the 64 sand water-drive fields on the A.P.I. list were lumped together. Thirty-six fields had closer spacing than 20 acres per well and recovered 625 bbl. per acre-foot, using arithmetic averages. The other 28 fields, with spacing wider than 20 acres, recovered 566 bbl. per acre-foot of pay sand. However, the average porosity in the close-spaced fields

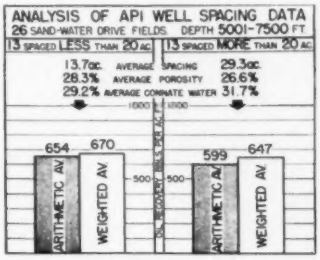

Fig. 3

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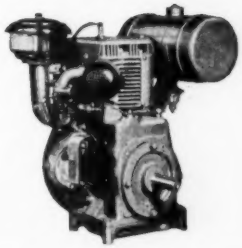

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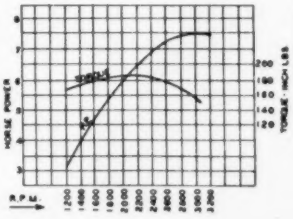

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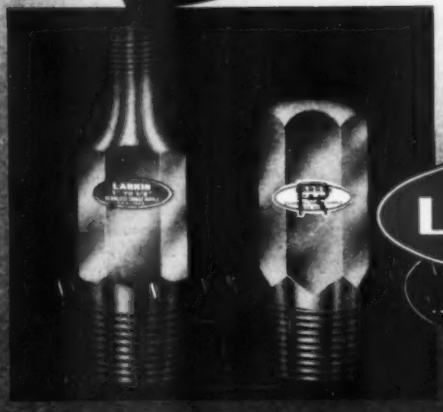

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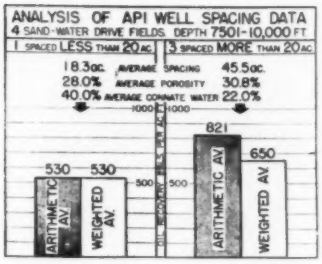

Fig. 4

was higher and the average connate water was lower than in the wide-spaced fields, and both of those factors are favorable to greater recoveries. A diagram has been prepared to show graphically the effect of these differences in porosity and connate water (see Fig. 5).

For the close-spaced and wide-spaced groups of fields, separate rectangles represents the volume of 1 acre-ft. A tank with capacity of 1 acre-ft. would hold 7,758 bbl. of oil or water. The close-spaced fields have average porosity of 28.6 per cent. On the diagram, 28.6 per cent of the space is marked as full of fluids, and the remaining 71.4 per cent as sandstone. In the fluids area, 27.7 per cent of the space is connate water amounting to 615 bbl. per acre-foot, and the remainder is 1,604 bbl. per acre-foot of original oil in place underground. Since the close-spaced fields will recover 625 bbl. of oil per acre-foot, they will recover 38.9 per cent of the original oil in the ground.

The wide-spaced fields have average porosity of 24.6 per cent. On their side of the diagram, 24.6 per cent of the space is marked as full of fluids, and the remaining 75.4 per cent as sandstone. In the fluids area, 29.0 per cent of the space is connate water, amounting to 566 bbl. per acre-foot, and the remainder is 1,355 bbl. per acre-foot of original oil. Since the wide-spaced fields will recover 566 bbl. of oil per acre-foot, they will recover 41.8 per cent of the original oil in the ground. That is 2.9 per cent higher recovery than the 38.9 per cent figure just given for the close-spaced fields.

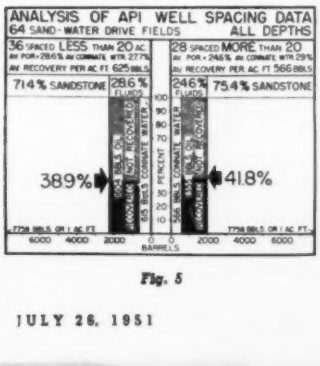
ANALYSIS OF API WELL SPACING DATA
64 SAND-WATER DRIVE FIELDS ALL DEPTHS
36 SPACED LESS THAN 20 AC
AV. POR.-28.6% AV. CONNATE WTR. 27.7%
AV. RECOVERY PER AC. FT. 625 BBLS.
28 SPACED MORE THAN 20
AV. POR.-24.6% AV. CONNATE WTR. 29%
AV. RECOVERY PER AC. FT. 566 BBLS.
71.4% SANDSTONE
28.6% FLUIDS
24.6% FLUIDS
75.4% SANDSTONE
625 BBLS. OIL RECOVERED
615 BBLS. CONNATE WATER
566 BBLS. OIL RECOVERED
566 BBLS. CONNATE WATER
1355 BBLS. OIL NOT RECOVERED
1604 BBLS. OIL NOT RECOVERED
389%
41.8%
7758 BBLS. OR 1 AC. FT.
7758 BBLS. OR 1 AC. FT.
PERCENT
BARRELS

Fig. 5

Thus, in this list of 64 representative fields, the close-spaced fields will recover less of the oil in place than will the wide-spaced fields. It can be concluded that the distance between wells is not the most important factor in oil recovery.

Hewitt field. — Tomlinson in his talks on well spacing has presented a statistical analysis of Hewitt field, an old and prolific oil field in southern Oklahoma. He states that one part of that field with wells close spaced produced more oil per acre than another part, which had wells wide spaced. He does not believe that the difference in the recoveries of the two parts of the field can be entirely explained by migration of oil from the wide-spaced area into the close-spaced area. He finds that there was not enough difference in the average sand thicknesses and average initial productions of the two areas to materially affect the oil recoveries. He therefore concludes that the close-spaced part of the Hewitt field recovered a larger proportion of the original oil under its area, because its wells were close spaced, and, for that reason, used less energy per barrel to move oil horizontally into the wells.

Tomlinson has published his Hewitt analysis in a paper distributed to the Research and Coordinating Committee of the Interstate Oil Compact Commission. His map of Hewitt is re-

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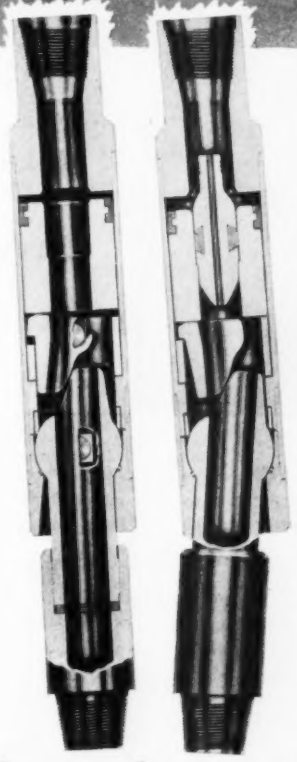

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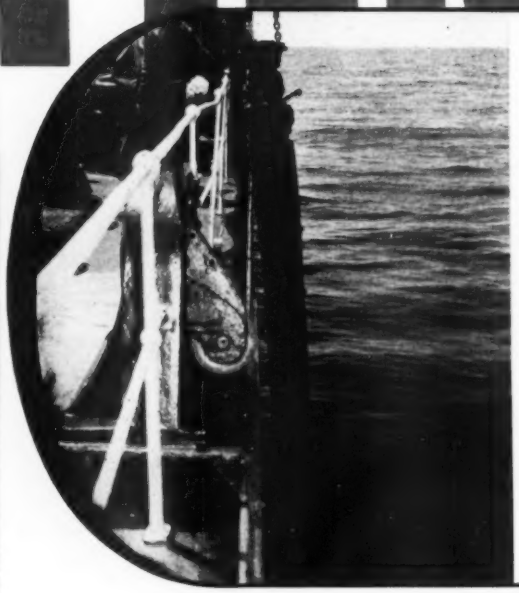

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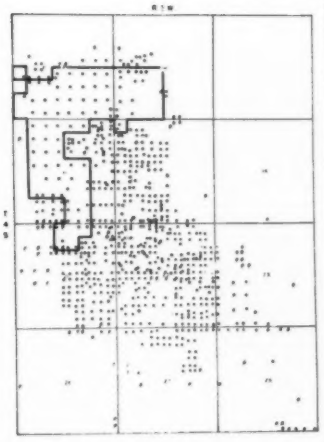

Fig. 6

produced here as Fig. 6. The heavy line on the map surrounds his wide-spaced area, and the rest of the field is his close-spaced area.

In an effort to verify Tomlinson's figures, a new statistical analysis has been made of Hewitt production records. In such an old field, cumulative production figures are not readily available, but scout reports of some companies did record the monthly production and number of producing wells on each lease. From scout reports in early years and from statistical production reports available for recent years, approximate figures have been assembled for the production from the discovery in 1919 through 1950. This new statistical analysis furnishes figures different from Tomlinson's, and lead to different conclusions about what happened at Hewitt.

The differences are shown in the following tabulation:

Close-Spaced Area

	Tomlinson	New analysis
Area size, acres	2,000	2,030
Spacing, acres per well	3.3	2.79
Recovery, bbl. per acre	*38,000	†36,116

Wide-Spaced Area

Area size, acres	800	758
Spacing, acres per well	9.6	5.45
Recovery, bbl. per acre	*20,000	†27,430

*Through 1945. †Through 1950.

The new analysis shows that the closed-spaced area of about 2,000 acres has produced somewhat less than Tomlinson reported, 36,116 bbl. per acre through 1950, as compared to his 38,000 bbl. per acre through 1945. For the smaller wide-spaced area all the figures are materially different. The new analysis shows that the area is smaller because part of the SW¼ of Section 10 is outside of the producing area. Tomlinson reported well spacing of 9.6 acres per well and it is now 5.45 acres. A special check shows that in 1925 it was

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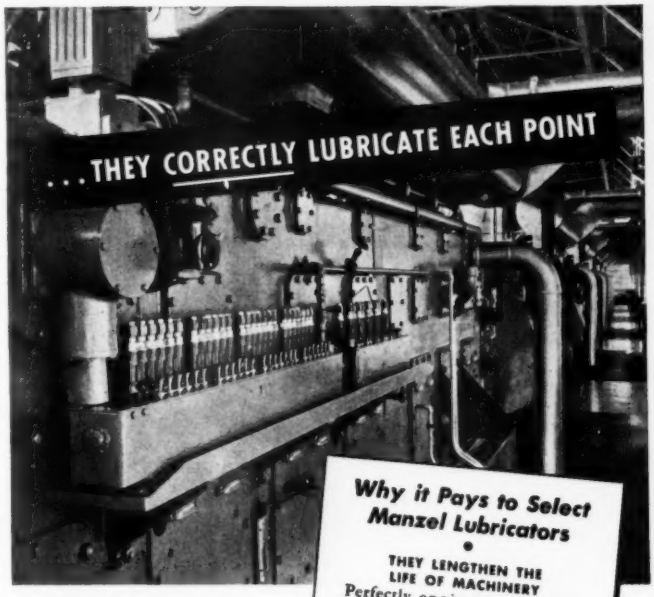

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6.83 acres and in 1930 6.21 acres per well.

The biggest difference is in the oil recovery, Tomlinson's 20,000 bbl. per acre compared to 27,430 bbl. in the new analysis. Tomlinson's figures for the two areas, 38,000 and 20,000 bbl. per acre, showed a spread of 18,000 bbl. per acre between the two areas, but the new analysis finds only 8,686 bbl. per acre difference between the new figures of 36,116 and 27,430 bbl. per acre.

In his discussion, Tomlinson tried to prove that the greater yields per acre from his close-spaced area could not be largely attributed to migration of oil from the wide-spaced area, because he considered the amount of oil too great and the distance too long for such migration. He stated his argument as follows: "The wide-spaced leases had produced an average of approximately 20,000 bbl. of oil per acre only, as compared with 38,000 bbl. per acre from the close-spaced leases. The increment obtained to that date from the latter, over and above what their cumulative production would then have been had they yielded no more oil per acre than the average for the wide-spaced leases, was over 34,000,000 bbl. of oil. If all of this excess had been obtained

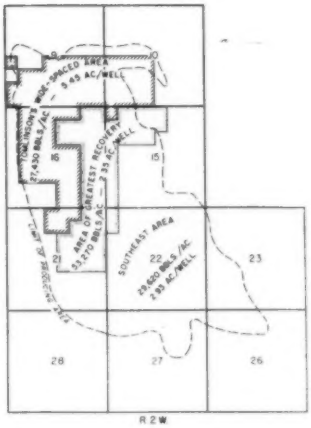

Fig. 7

by migration of oil which originally lay under the 800 acres of wide-spaced leases, those leases had to give up in that manner, to wells outside their border, 170 per cent of the quantity of oil they produced through their own wells."

He has stated that his wide-spaced area covered 800 acres and produced 20,000 bbl. per acre, which totals 16,000,000 bbl. The close-spaced area covered 2,000 acres and produced 38,000 bbl. per acre, which totals 76,000,000 bbl. If the 2,000 close-spaced acres had produced no more than the 20,000 bbl. per acre of the wide-spaced area, they would have made only 40,000,000 bbl. The increment of production that they did make above 40,000,000 bbl. was 34,000,000 (or 36,000,000) bbl. If all of this excess of 34,000,000 bbl. had been obtained by migration of oil from the 800 acres, those leases had to give up by migration 170 per cent of the quantity of oil they produced through their own wells.

That is not a reasonable argument, and can be better analyzed as follows:

Since his wide-spaced area produced 16,000,000 bbl. (800 acres times 20,000 bbl. per acre), and this close-spaced area produced 76,000,000 bbl. (2,000 acres times 38,000 bbl. per acre), the entire pool produced 92,000,000 bbl. from 2,800 acres, an average of 32,800 bbl. per acre. The excess production of the close-spaced area above the 32,800 bbl. per acre field average totals 10,300,000 bbl., a gain of 15.7 per cent. The amount that the wide-spaced area is below the average is the same 10,300,000 bbl., a loss of 39 per cent.

If the same comparison is made using the figures from the new statistical analysis of Hewitt, the amount of oil that might have migrated is even less.

The new figures show his wide-spaced area produced 20,800,000 bbl

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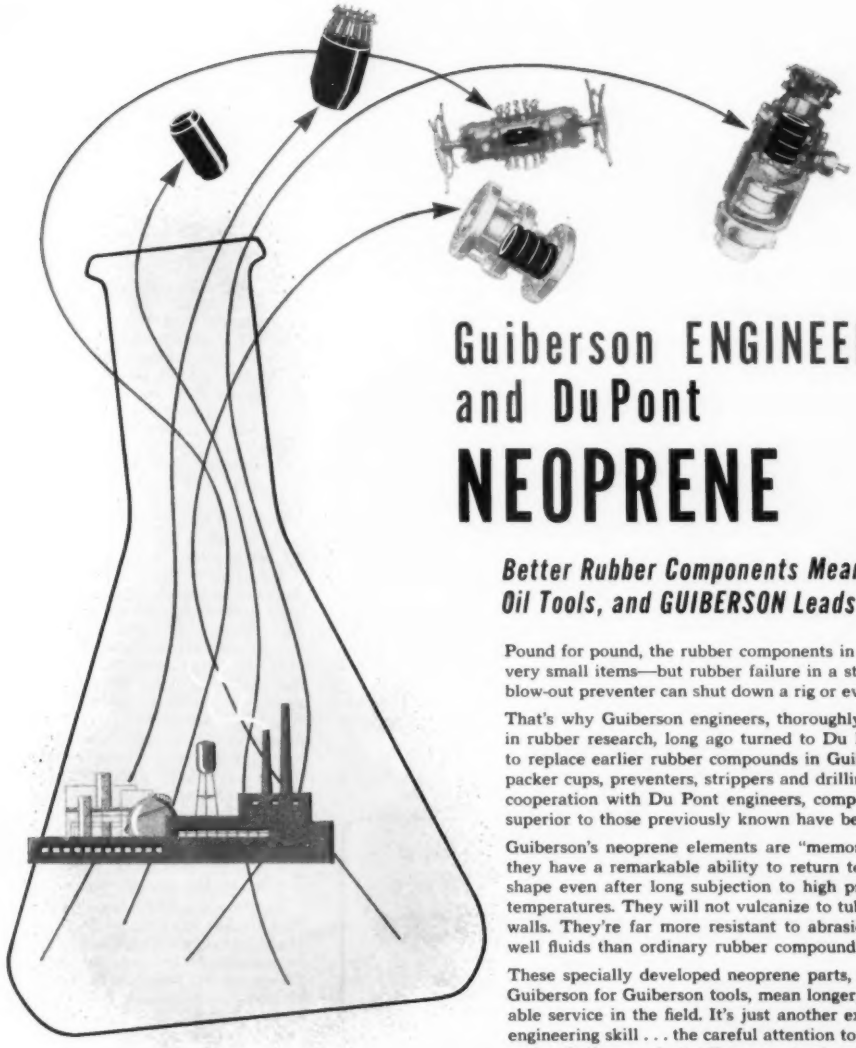

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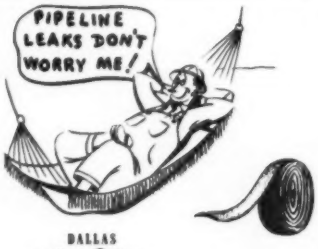

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(758 acres times 27,430 bbl. per acre), and his close-spaced area produced 73,300,000 bbl. (2,030 acres times 36,116 bbl. per acre). The entire 2,788 acres produced 94,100,000 bbl. of oil, a field average of 33,751 bbl. per acre. The excess of the close-spaced area over the average is 4,800,000 bbl., a gain of only 7 per cent. The amount that the wide-spaced area is below the average is the same 4,800,000 bbl. or 18.7 per cent. Contrary to Tomlinson's reaction, it appears quite possible for that much oil to migrate in a field where all wells were produced wide-open without any restrictions, and where there were differences in density of well spacing.

The oil-recovery figures for individual leases at Hewitt have been studied, and show wide variations. There are much greater differences in recovery between many adjacent leases in both of Tomlinson's wide-spaced and close-spaced areas, than the 18,000 bbl. per acre difference he reported between the averages of his two areas.

To further check what may have happened at Hewitt, another area was marked off on the map to cover a strip ½ mile wide along the east side of Tomlinson's wide-spaced area (see Fig. 7).

This 505-acre area, here called the Area of Greatest Recovery, includes some of the richest leases in the field, and has averaged to the end of 1950, 53,270 bbl. per acre with spacing of 2.35 acres per well. It might be argued that this middle area had twice the production of the northwest or wide-spaced area, because the well-spacing was more than twice as close. However, that argument falls down when the middle area is compared to the southeast area, which is the 1,372-acre remainder of Tomlinson's close-spaced area, because the middle area produced 80 per cent more oil per acre than the southeast area with spacing in the middle area only 20 per cent closer than in the southeast area.

Likewise, the recovery of the southeast area, 29,620 bbl. per acre, is not much more than the 27,430 bbl. per acre of the wide-spaced area, although the well spacing was twice as close. It is more reasonable to assume that the middle area had the best permeability and other better conditions, and, in an old unprorated field where the "right of capture" prevailed, may have drained some oil both from the northwest and southeast parts of the field.

It is interesting in 1951 to see that in 1921, when Hewitt had been producing less than 2 years, Swigart and Schwarzenbek in a U. S. Bureau of Mines report on Hewitt field predicted wide differences in ultimate production because of great differences in initial well productions. They attributed the differences to variations in the thickness and character of the sands, to position on the geologic structure, and to the presence of gas in the sands in some areas. For the top Hewitt sand alone, which was most extensively developed in 1921, they predicted ultimate recoveries varying from 3,000 to 15,000 bbl. per acre, a one to five variation. Conditions in the several other sands in the Hewitt producing section were similar to the top sand.

Tomlinson, with his analysis of Hewitt, has not proved that the distance between oil wells is the most important factor in oil recovery. There are so many variables in the recovery problem at Hewitt, and in all other fields, that statistical analyses of fields will never settle the well-spacing problem to everybody's satisfaction.

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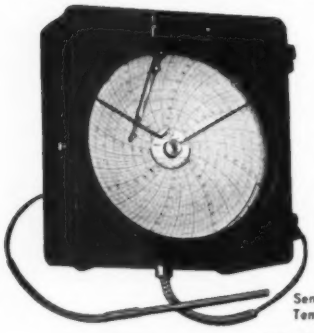

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Applications of the Productivity Index

(Continued from page 237)

permeability fraction to give the productivity index at each reservoir pressure." But he analyzes that the productivity index so obtained is the **zero flow index** and must be modified to account for drawdown. Fig. 1 correlates the calculated productivity index for an average well in a San Andres (Permian) dolomite reservoir in West Texas, with the pressure behavior of several physical properties of hydrocarbons.

Observed factors. — Other factors which may influence the observed productivity index include: the completion method, the sanding up of well bore in unconsolidated media; the mudding off of the pay zone, the clogging of perforations. Obviously, important factors are the normal decline in productivity index as a function of pressure depletion and the effects of pressure transients arising from changes in production rates.

Choice of completion method.—Various completion methods may be compared by correlation of their observed initial productivity indexes. The value of open-hole, liner, or perforation completion can be evaluated by the use of this method for each of these conditions. Synthetic drilling fluids for protection of naturally effective p.i. can also be compared rigorously only by this method.

SOURCES OF DATA
For Calculating the Productivity Index

THE FLUIDS:

Hydrocarbon characteristics are obtained from either the bottom-hole sample of the reservoir oil or the recombined two-phase separator sample. In either case, the properties sought are the viscosity, the formation volume, and the solubility gas-oil ratio at various pressures.

THE ROCK:

Rock or media characteristics are commonly obtained from core data to obtain the porosity, permeability, and fluid saturations. Mechanical analyses are employed in the analysis of grain-size distribution which in turn determines permeability distribution.

INTERACTION OF ROCK AND FLUIDS:

Core data are employed for the determination of the relative permeability of the rock to either the gas or the oil phase as a function of liquid saturation.

The engineer is assisted in the selection of the optimum size of the number of quarts of nitroglycerin or the number of gallons of acid for a stimulation job by studies of individual well behavior and their response under comparable conditions. He may employ the graphic method for the determination of optimum shot density by plotting on coordinate graph paper the values of $(P.I.)_a/(P.I.)_b$

where

$(P.I.)_a$ = observed productivity index after shot.

$(P.I.)_b$ = observed productivity index before shot.

The interpretation of the graphic relationship should be guided with

TABLE 1—EFFECT OF ACID TREATMENT UPON THE PRODUCTIVITY INDEX CLEAR FORK (PERMIAN) INTERGRANULAR DOLOMITE, WEST TEXAS BASIN

Zone	Depth range	P.I., bbl. fluid/day/psi. Before acid	After acid	Per cent change
A	6,750-6,950	0.08	0.2	150
B	6,950-7,060	1.14	3.6	216
C	7,100-7,250	0.25	1.7	580

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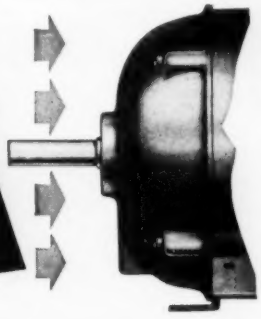

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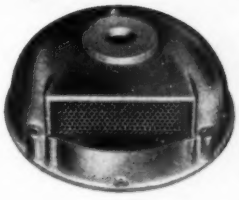

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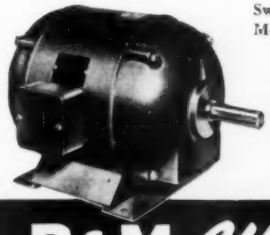

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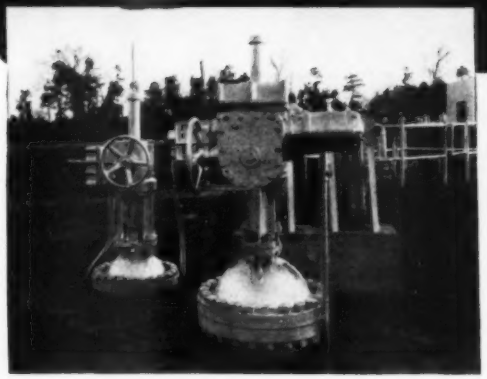

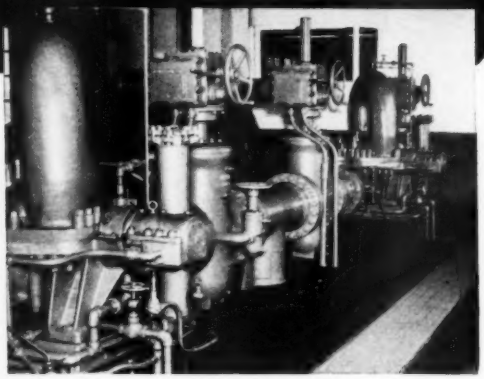

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the recognition of the existence of, and extent of, possible shale barriers in the pay section subjected to shooting. In addition, some consideration should be given to the absolute permeability of the media.

Highest capacity zone.—The problem of completing oil wells in a field exhibiting low A.P.I. gravities was solved by one leading company by the procedure of measuring the productivity index on drill-stem test for a series of penetrations in the thick Woodbine formation encountered in the highly faulted Hawkins field of Wood County, Texas.

The flowing bottom-hole pressure was measured at a given penetration, then the well was flowed under three different rates at that depth, the productivity index calculated, and the process repeated as each significant new pay in the Woodbine was reached. The fluid production referred to a 24-hour basis, divided by the pressure differential, gave the **observed** productivity index at each penetration. Thus, by correlating the productivity index versus depth, the engineer could ascertain at which level he could obtain the highest possible capacity. In addition to being used at Hawkins, this method has been widely used in a number of South Texas sandstone reservoir completions.

Effect of acidization.—Another method that may be used in the selection of the depth at which the highest capacity well may be developed in a thick producing formation utilizes the response of the formation to acidization or shooting at various producing depths and the correlation of the p.i. values taken before and after treatment in each pay zone. This is shown in Table 1. Note that the best increase occurred in the 7,100-7,250-ft. interval as contrasted with poorer effects following treatment opposite the 6,750-6,950 and the 6,950-7,100-ft. zones.

Workover operations.—Good engineering practice calls for frequent observation of the production behavior of each well. The case history can be developed through the taking of an initial productivity index and others in later stages of the life of the well. The p.i. values should be plotted versus cumulative production for analysis. By noting which wells exhibited abnormally rapid declines in productivities, engineering recommendations may be made for the purpose of restoring the capacity of the well. A low productivity index may reflect the effect of partially plugged casing or liner or tubing perforations. In this connection, the theoretical effect of perforations and size of casing on the productivity index of an oil well is shown in Fig. 2 (after Muskat).

The effect of cleanout or workover operations on a given well can be evaluated by taking a p.i. after the job and comparing it with a test conducted before the workover was made. Where shooting or acidizing is employed in the workover job, the effect may readily be evaluated in the manner explained earlier in this article. The results of a series of workovers of a certain type in a given formation can be plotted and correlated. From this study, the immediate benefits of a specially designed workover may be analyzed and its practical value in future jobs on the same or adjacent leases may be judged.

Field development.—A p.i. survey may be conducted in a field and the results plotted in several ways:

1. Preparation of a p.i. contour map.

2. Preparation of a specific productivity index contour map (where the sandstone is fairly homogeneous, this method may prove useful).

3. Preparation of "an indicated capacity contour map" (p.i. × static b.h.p.).

4. Superimposing a p.i. profile on a pay section cross-section.

The above maps may be studied in conjunction with the subsurface structural, contour map, the net oil-pay isopachous contour map, and the bottom-hole-pressure contour map. The data obtained from observed productivity indexes may be utilized in the development or exploitation of a new field or in the recognition of a new

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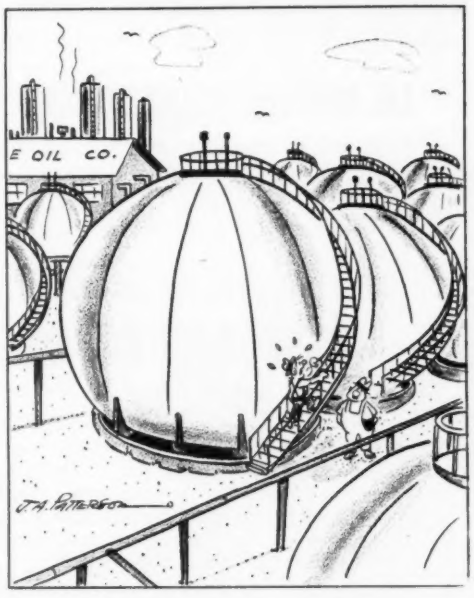

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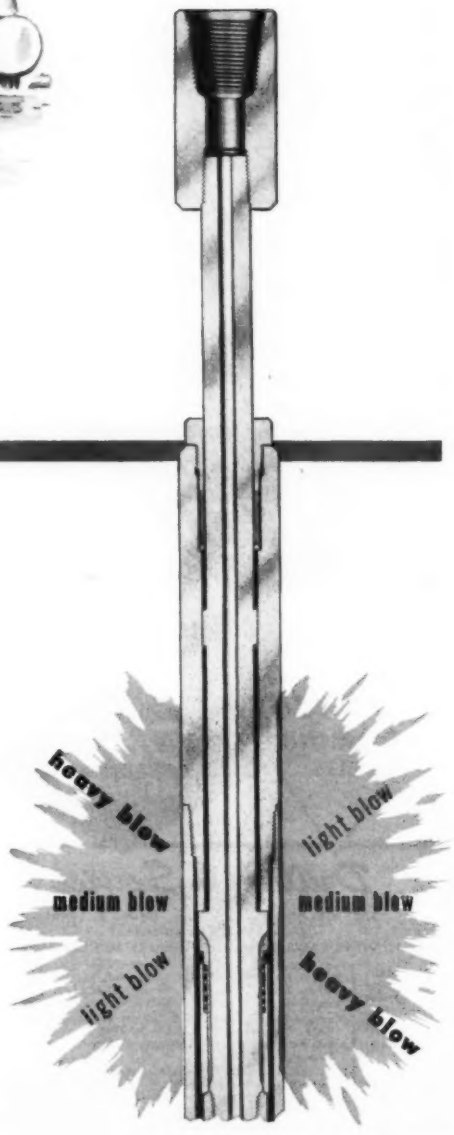

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fault segment adjacent to an older-developed reservoir.

Analysis of continuity.—Limited application of p.i. data may be made in the analysis of the continuity of an oil pay. The existence of a sharp break in the absolute values of the p.i. in a portion of the reservoir may suggest discontinuity, poor permeability development, or depletion. However, the effect of penetration on the value of the p.i. is important to recognize in this interpretation.

In one case history, the existence of a cross fault was confirmed by the change in the magnitude of p.i. values on one side of the fault as contrasted by higher values measured on the opposite side. The differences could not be explained by the effect of varying pay penetrations. Poor permeability development was the principal cause of the lower productivity index value measured on one side of the fault.

The effect of gross oil-pay penetration of Tensleep reservoir of a Rocky Mountain structure versus observed productivity index is shown in Fig. 3, "Penetrated Gross Oil Pay vs. Productivity Index." The graph shows two conditions: (1) that for a given penetration, the south dome wells generally obtain higher values; and (2) that productivity capacity of Tensleep reservoir in this area is derived principally from upper 150 ft.

Secondary Recovery Applications

Injectivity index. — The reverse of productivity index is injectivity index. Dickey and Andresen[5] have shown that determination of "restricted injectivity index" is a satisfactory criterion for behavior of an input well. They found experimentally that, if an input well is shut in for a sufficient period until well-head pressures show a low decrement, and water is injected for equal short-time intervals (5 minutes) at each of several successively higher pressures, injection rate is directly proportional to pressure.

When injection rate is plotted against injection pressure on rectilinear coordinate paper, a straight line is obtained. Slope of this line is termed restricted injectivity index since the test is conditioned for a short-time duration by conductivity of media to water at well bore.

A useful unit for comparison of water-intake capacities of wells is the specific injectivity index, obtained by dividing the injectivity index by effective exposed pay sand thickness.

Slope of pressure input curve remains fixed with time where a reservoir has its void space completely filled with liquids and where there is no sand plugging. Shown in Fig. 4 are field experiments conducted by Grandone and Holleyman[6] who found that the two specific injectivity indexes obtained on the same well exactly 1 month apart to be identical; 0.0064 bbl./day/psi./ft.[3] of sand. The two shutin pressures of 192 and 240 psi. on pressure axis represent conditions when well was stabilized at beginning of each injection test. Thus the curve shifts with the magnitude of shutin pressure.

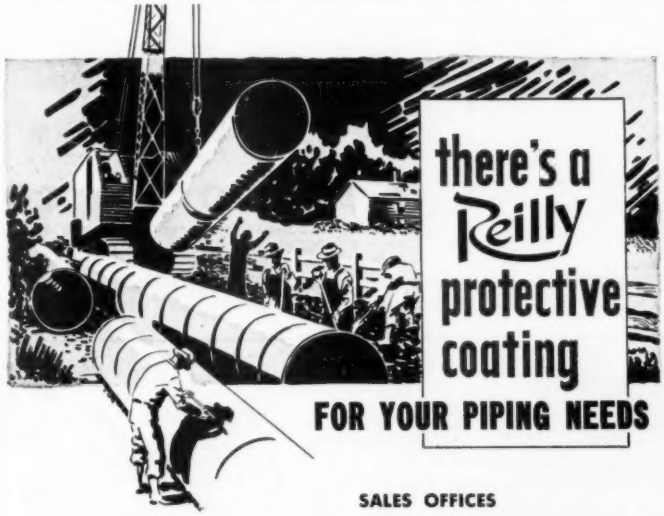
As magnitude of pressure rises in a reservoir that has its pore space saturated with liquid, the injection pressure must be raised to maintain a given input rate. However, for a reservoir that does not have its pore space completely filled with liquids, the slope of pressure-input curve is steeper at the time water injection is initiated, and continues to flatten until pore space is filled.

Mathematical concept. — Since injectivity index represents relationship between change in rate and change in pressure, the expression may be expressed mathematically by placing radial flow equation in differential form as:

$$\frac{dQ}{dP_w} = \frac{2.2543 \pi k h}{\mu} \times \left(\frac{1}{\log_e r_e/r_w} \right) \qquad (2)$$

where

Q = rate of intake, bbl./24 hours.
k = effective permeability, darcies.
P_e = pressure at equilibrium point in reservoir, psig.
P_w = pressure at sand-face, psig.
h = net effective exposed sand thickness, ft.
$\log_e$ = natural logarithm, base e.



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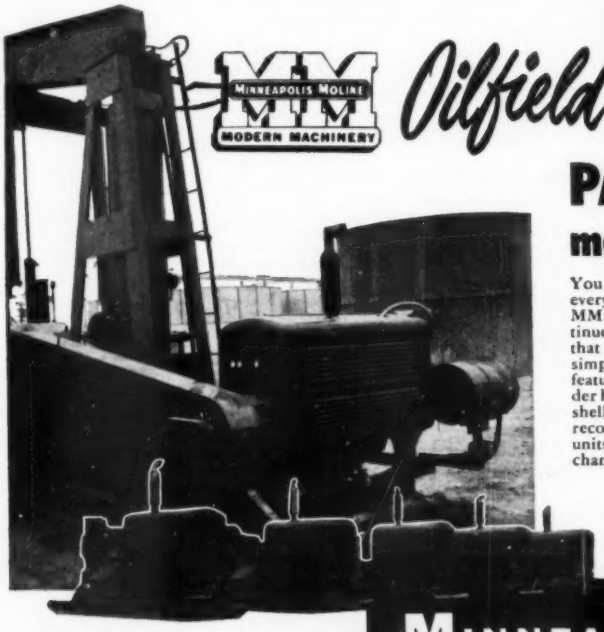

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r_e = distance from sand-face to point where pressure is P_e, ft.
r_w = effective radius of well-bore, ft.
μ = viscosity of reservoir oil, cp.

Practical Limitations

It has been said that "productivity indexes and their measurement have lagged behind the entire field of reservoir engineering." One major oil company believes that every well should be carefully tested on initial completion; productivity indexes would be obtained at a series of flowing rates. These values would be used for comparisons later in the life of each individual well. This company believes that a productivity index, properly measured, is one of the most important reservoir measurements and one of the lowest-cost items. Certainly, a bottom-hole-pressure measurement is a low-cost item of field work. Yet, this firm states that, "we do not have 1 per cent of productivity index test data that we need."

Too often, a well problem arises which calls for a productivity index. At the time, the well in question is not in condition for taking of a p.i. test; the well may have sanded up, perforations may have been clogged, or other factors may preclude taking of the test.

Causes of discrepancies.—The following analysis may help to explain some of the causes of discrepancies between calculated and observed productivity indices:

1. Inadequacy of sampling.

A. Impossibility of obtaining complete sampling representation of variations in reservoir media, fluids and fluid saturations.

B. Existence of extreme variations in specific permeability in limestone and dolomitic limestone media.

2. Inherent shortcomings of laboratory technique.

A. Measurements of permeability to air do not duplicate reservoir conditions.

B. Existence of so-called end effects in the core holder.

C. Existence of surface-tension effects at atmospheric pressures and temperatures.

D. Reservoir fluid mechanics approach three-phase flow as contrasted with measurements of permeability to single-phase or dual-phase flow in the laboratory. (See Fig. 5.) Conclusions drawn from the application of laboratory flow studies are limited by the following assumptions: (1) that phase equilibrium exists at all times; (2) that a linear relationship exists in the solubility of the dissolved gas with pressure (Henry's law), and (3) that there is an agreement of free gas behavior with the perfect gas law.

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FIG. 4721

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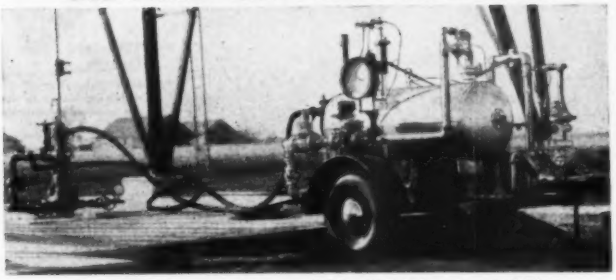

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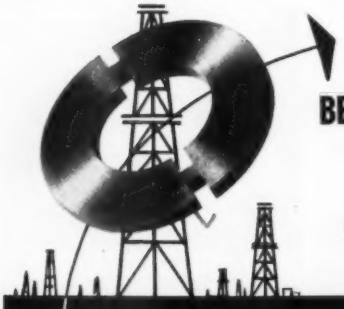

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productivity indexes, one must realize that what is measured is a resultant of many factors for a very, very limited sampling period. The effect of pressure transients occurring at the well bore due to change in producing rates is of major importance.

Another fallacy is to assume that a well is shut in when the surface valves are closed; yet the formation fluid is still feeding into the well since there are changes in the fluid level despite the closed position of the well-head valves.

Field Measurements

Flow-test standardization. — Problems of field applications can be summarized as follows: First, there is no real standardization of flow-test procedures for the taking of productivity indexes. Unless we are very precise in measurement, it would be extremely difficult to obtain valid conclusions. Gas-oil-ratio data at low rates of fluid flow and low pressure drawdowns are often subject to serious errors in measurement. It would be ridiculous to calculate p.i. values to three significant figures when there may be a discrepancy of from 20 to 30 per cent in the gas volume measurements accompanying the tests.

Adequacy of measurements. — The application of productivity-index data to any of the above uses should be carefully analyzed from the standpoint of adequacy of field measurements. Hence precautions should be taken to insure:

1. Elimination of gage errors in bottom-hole-pressure measurement.
2. Elimination of interpretation errors in bottom-hole-pressure measurements.
3. Elimination of significant errors in gas volume measurements.
4. Adequacy of the shutin time or proper compensation of the field; this must take into consideration the permeability of the system, the permeability distribution in the well, the well density, interference between wells, and the subsurface structural relief of the adjacent areas.
5. Proper stabilization of the subject well between successive productivity index measurements at various oil rates.

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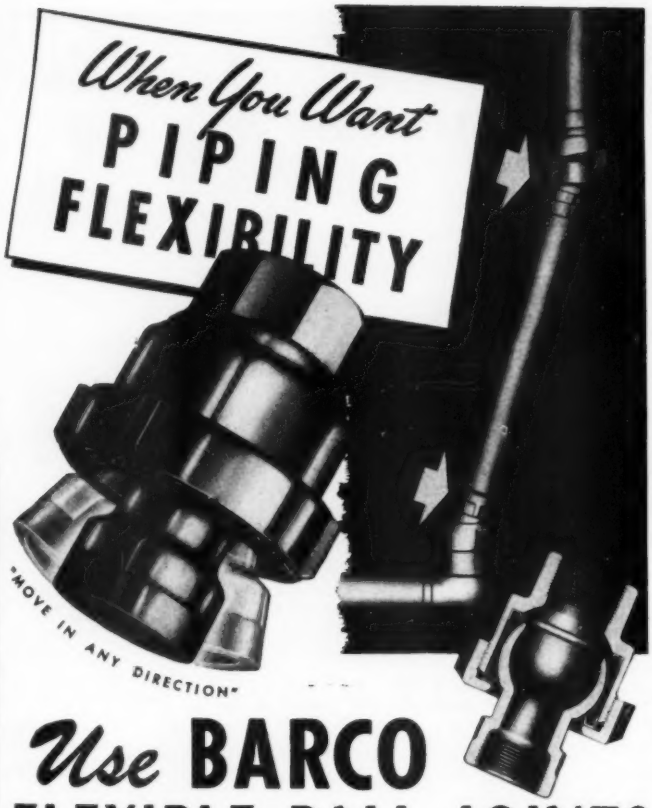

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New Light on

CENTRIFUGAL-BOOSTER PERFORMANCE

and its relation to gas pipe-line capacity

by J. H. Anderson*

THE planning and operation of a crosscountry gas pipe line are exceedingly complex problems involving a lot of engineering, economics, and good judgment. The advent of the centrifugal gas booster driven by electric motor, steam turbine, gas engine, or gas turbine has created a number of new problems because its operating characteristics differ fundamentally from those of a reciprocating compressor. This article discusses the operating characteristics of the centrifugal compressor and their relation to pipe-line operation. No attempt is made in the discussion to evaluate or pass judgment on the economics of pipe-line-station spacing except as they are affected by operating characteristics.

The pipe line is basically a channel through which gas flows with a continual loss of available energy through friction. This loss manifests itself in a reduction in pressure and can be expressed mathematically in a number of ways, of which the following equation is typical:

$$Q = 879\ \text{"E"}\ (d)^{2.6182} \times P_1^{1.0788} \times [(1 - P_2^2/P_1^2)/L]^{0.5394}$$

where:

Q = cu. ft. per day gas at specific gravity = 0.60 temperature = 60° F. and pressure = 14.9 psia.

d = inside diameter of pipe in inches.

P_1 = initial pressure in psia.

P_2 = outlet pressure in psia.

L = length of pipe in miles.

879 = constant depending on condition of pipe.

E = line efficiency factor to allow for condition of line.

*Ingersoll-Rand Co., Phillipsburg, N. J.

ENGINEERING *Reference Section*

The line flow function is defined as the term in the basic equation. Note that it is directly proportional to flow when the pipe size and initial pressure are constant.

Fig. 1 shows this equation plotted for various values of length, diameter, and initial pressure at the station discharge. Note that in this article station discharge pressure is equivalent to P_1 or initial pressure to the pipe line, and station intake pressure is equivalent to P_2 or outlet pressure from the pipe line. Knowing any five of the factors in the equation, the sixth can be solved by the use of the chart. For convenience, the station discharge pressures are given in gage pressures, although all calculations must be made in absolute pressure units.

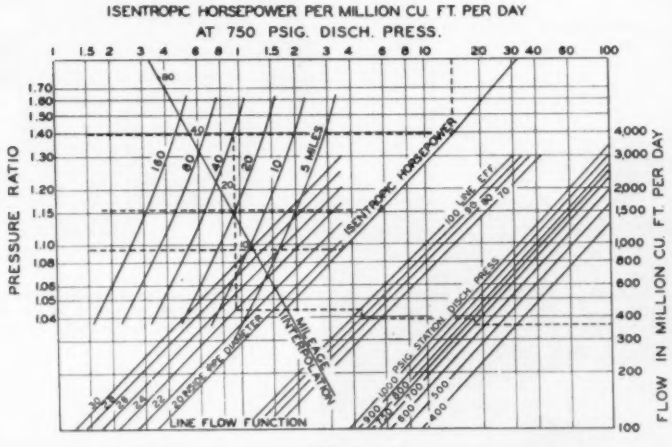

Fig. 1.

Example.—A 24-in. pipe, 40 miles between stations operates at 700 psig. station discharge pressure with a daily flow of 360 million cubic feet and a line efficiency of 90 per cent.

Solution.—Start at the right-hand scale (Fig. 1) at 360 million cubic feet daily, move left to the 700-psig. line, up to the 750-psig. line, left to the 90 per cent efficiency line, up to the 100 per cent line, left to the 24-in. line, up to the 40-mile line, and left to the pressure ratio of 1.392. Divide the initial pressure (700 + 14.7) 715 psia. by the pressure ratio. This gives an outlet pressure of 513 psia.

The real measure of the loss is the horsepower required to compress the gas through the given pressure ratio. This is obtained by going to the right from the pressure ratio of 1.392 to the horsepower curve and turning up to read the theoretical horsepower of 14.1 per million cubic feet per day.

Actual shaft horsepower required will be theoretical horsepower divided by the adiabatic or isentropic efficiency of the booster. The isentropic horsepower curve is plotted here for 750 psig. discharge pressure, 0.60 specific gravity, 60° F. intake temperature, and compressibility according to California Natural Gas Association tables. Other operating conditions somewhat affect the compressibility factor and horsepower, but the error is not very great in the general application range of this chart.

Horsepower Requirements

Example.—A comparison of horsepower requirements for different station spacings is easily made, as shown in Fig. 1. Using the previous conditions and a spacing of 20 miles the pressure ratio per station is 1.154 and the theoretical horsepower is 5.85.

Solution.—Since there are now two stations in 40 miles the total theoretical horsepower is 2 × 5.85, or 11.7 hp. per million cubic feet daily. This shows a 17 per cent saving in horsepower over the 40-mile spacing. If we go to 13.3-mile spacing, or three stations in 40 miles, the pressure ratio is 1.093 and the horsepower per station is 3.60, a total of 10.8 hp., or a saving of only 7.6 per cent over

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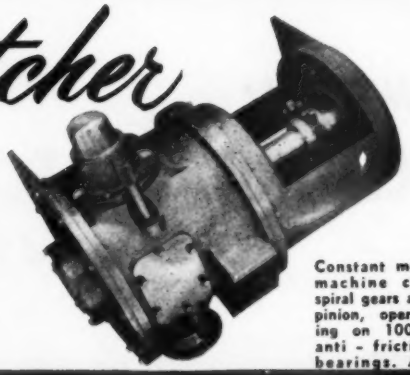

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SPECIFICATIONS

CAPACITY: Depth of cut, 8' 6". Swing arc to [illegible]

GENERAL DIMENSIONS: Overall width, [illegible]

O.A., 13' 4½" — Traveling length, 40' 0" — Width over crawler, 12' 5½".

CRAWLERS: Caterpillar D7's, 24" wide.

POWER UNIT: Caterpillar D7000, H.P. 115 @ 350 R.P.M.

FRONT WHEEL: Steered hydraulically by hydraulic motor with worm and worm gear enclosed, running in oil.

EXCAVATOR WHEEL HOIST: Front and rear excavator digging hoist as well as conveyor hoist hydraulically driven enclosed in single case, running in oil.

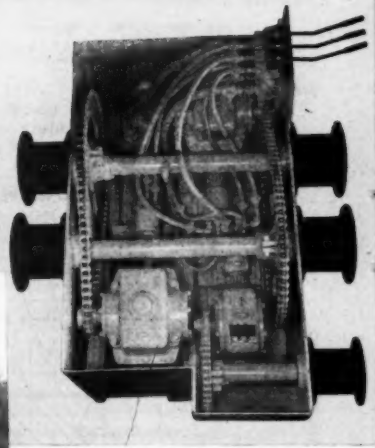
EXCAVATING WHEEL: Pin work 1" x 9", 30' 2" I.D.

CURRENT GEARING: American Manganese Steel. Normal Speed of digging wheel at cutter points, approximately [illegible] per min.

CONVEYOR: Removable sections for narrow or wide trenches, width of belt, 36". All inner and outer belt rollers anti-friction bearings. New type silent center belt guides. Conveyor drives independent of digging wheel by hydraulic motor allowing any variable speed of conveyor belt.

ROAD SPEED: Approximately two miles per hour.

WEIGHT OF COMPLETE MACHINE: Approximately 74,000 lbs.



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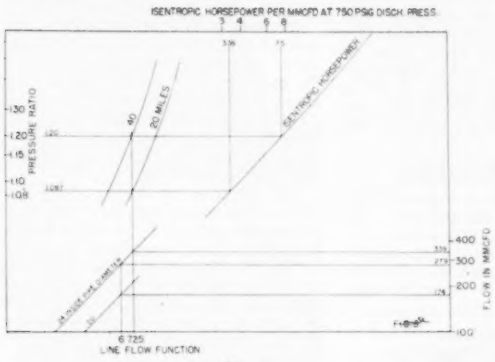

Fig. 2.

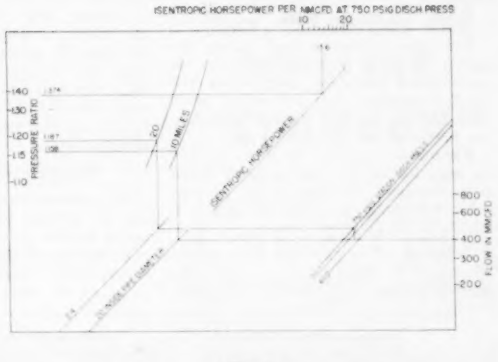

Fig. 3.

the 20-mile spacing. The method of interpolation between the 10-mile and the 20-mile line to arrive at the 13.3-mile line is shown on the chart, and is done as follows:

1. Find 13.3 on the extreme left-hand scale of the chart.

2. From 13.3, the intersection point of a horizontal line and the mileage interpolation line, drop vertically to intersect the line marked 1 on the extreme left-hand scale.

3. The 13.3-mile line passes through this point and is parallel to and horizontally equidistant from the 10-mile line.

Parallel Pipes

Performance of pipes in parallel are easily obtained as shown on Fig. 2. With two pipes in parallel, the pressure drop between two common points is the same. Therefore, the flow function is the same for both.

Example.—If we have a 20 and a 24-in. line in parallel we can get the ratio of the flow in the pipes by comparing the two flows at any single value of the flow function, let us assume 6.

Solution.—The flow for each pipe is at 750 psig., 279 million cubic feet daily for the 24-in. and 174 for the 20-in. The sum of the two is 453 million cubic feet daily and the 24-in. pipe carries (279/453) 61.7 per cent of the total flow.

Now suppose we want to find the pressure ratio and horsepower loss for this combination with 550 million cubic feet daily at P_1 = 750 psig.; 61.7 per cent of 550 is 339. Reading left from 339 to the 24-in. line we get a flow function of 7.25. For a 40-mile spacing the pressure ratio is 1.20 and the theoretical power is 7.5. For a 20-mile spacing the pressure ratio is 1.087 and the theoretical horsepower is 3.38. Note that in this and all following examples the line efficiency factor has been left out to simplify the descriptions. This is permissible because so far as the booster is concerned, a change in line efficiency is

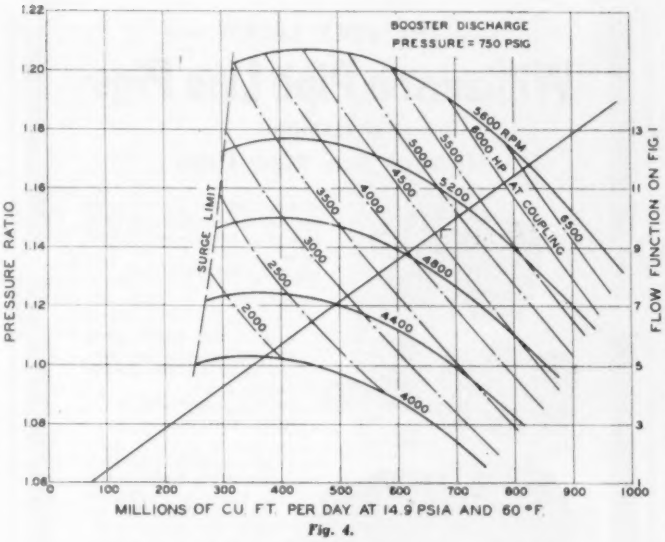

Fig. 4.

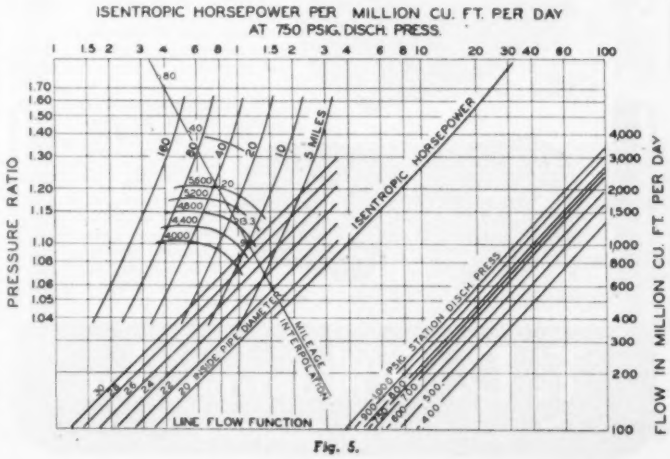

Fig. 5.

the same as a change in pipe diameter.

Series Pipes

For two different-sized pipes in series the total pressure ratio is the product of the two ratios, but we must remember that the initial pressure for the second pipe is the outlet pressure of the first pipe.

Example.—Assume 10 miles of 20-in. pipe followed by 20 miles of 24-in. pipe. Suppose the flow is 400 million cubic feet daily at an initial pressure of 750 psig.

Solution.—The pressure ratio of the 10 miles of 20-in. pipe is 1.158, as shown in Fig. 3. The initial pressure for the following pipe is (765/1.158) 661 psia. or 646 psig.

Taking this initial pressure with the flow of 440 million cubic feet through 20 miles of 24-in. pipe we find the ratio to be 1.187. The overall ratio is 1.158 × 1.187, or 1.374, and the theoretical horsepower required is 13.6 per million cubic feet daily.

Gas-Booster Performance

The performance of a gas booster can be plotted on the pipe-line loss curve by the following method:

Example.—Suppose we are considering a flow of 675 million cubic feet daily at an initial pressure 750 psig. through a 28-in. line with 20-mile station spacing. The pressure ratio is 1.16.

Solution.—The characteristic performance curve of the booster to fit these conditions is shown in Fig. 4. To plot this on the chart we let the rated capacity of the booster at 675 million cubic feet daily equal the line flow function of 9.6 and plot the pressure ratio of the booster at proportional flow functions.

For instance, at 5,200 r.p.m. and 500 million cubic feet daily we read a pressure ratio of 1.175. We plot this point at a flow function of (500/675) 9.6 or 7.1. In this way we can plot the complete booster performance, as shown on chart, Fig. 5. On this chart we can easily trace the performance of the line at various conditions. For instance, following our 20-mile resistance curve we note that the flow function goes up to 10.1 at the top speed of 5,600 r.p.m. This corresponds to a flow of 720 million cubic feet daily, the maximum flow this booster could put through the line. If we reduce the booster speed to 4,800 r.p.m. the line flow would be reduced to 630 million cubic feet daily.

Note that as long as the stations are operating on 20-mile spacing the performance points on the booster are at the intersections of the booster curves and the 20-mile resistance curve.

Part-Load Characteristics

Now let us consider what happens when a station is cut out and the spacing goes to 40 miles. Looking at the intersection of the upper booster curve and the 40-mile resistance curve we see that the line capacity is reduced to 520 million cubic feet daily. Under these conditions the line capacity can be maintained by cutting out every other station all along the line or by spacing all the stations at the downstream end 20 miles apart and running them at a low speed corresponding to a pressure of 1.090.

Which of the above schemes is more economical depends upon the part-load characteristics of the power unit. For instance, in the case of a single-shaft gas-turbine unit with poor light-load efficiency, it would probably be more economical to cut out alternate units. In that of a steam-turbine unit with good part-load efficiency it might be more economical to keep all units possible in service because the shaft horsepower of the boosters is lower. With a constant-speed motor-driven booster, alternate units should be cut out because there is practically no saving in power per booster at reduced pressure ratios. The reason for this is that the reduction of pressure ratio in a constant-speed booster is essentially a throttling process.

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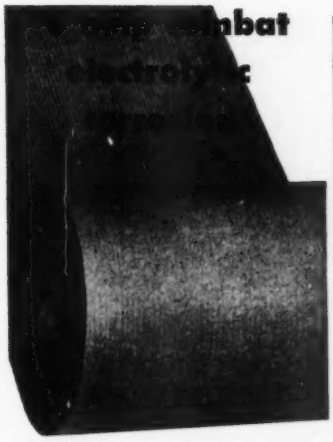

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selves may be there will inevitably be some outage time. It is therefore highly important to arrange the system in such a way that there will be the least possible reduction in capacity when a unit is cut out. To do this and still maintain high line pressure, the obvious remedy would seem to be an increase in the number of units in each station. As opposed to this, a few large-capacity units might be more desirable from the standpoint of simplicity. Let us analyze this and first examine the effect on capacity of the loss of one unit from a station with two in series.

Example.—Take the same case as before—two units in a station, 40-mile spacing.

Solution.—With two units running at 5,200 r.p.m., the flow function is 9.0 at a pressure ratio of 1.16^2, or 1.346. With one unit in operation the flow function drops to 6.8 at a pressure ratio of 1.175. We have reduced our capacity to 6.8/9.0, or 75.4 per cent of full-load capacity. Our power dropped from (9.0 × 12.6) 113.4 to (6.8 × 6.7) 45.5, or 40.2 per cent of the full horsepower for the two units.

It would be desirable, since we can't speed up the electric motor, to have a steeper booster characteristic curve so that the single-unit curve would intersect the 40-mile resistance curve at high enough value to use the full horsepower of the motor. This would give us a higher capacity with the one unit out of service. If we have three units per station instead of two in series, the capacity would still remain at 85 per cent of full capacity with one unit out of service.

Variable Speed Drivers

Now, since we have seen that constant-speed electric drive does not permit full utilization of the available horsepower at conditions of partial capacity, let us examine the characteristics of variable-speed drivers.

Example.—Going back to our case of two units in series; if our driver could produce constant horsepower at variable speed we could speed up the booster to the point where it would use all the driver's available horsepower with one unit out of service.

Solution.—Letting our power equal one-half of 113.4 or 56.7 and coming down the 40-mile line till the flow factor times the isentropic horsepower equals 56.7, we intersect at a flow factor of 7.3 and a pressure ratio of 1.205, requiring a speed of 5,600 r.p.m. The capacity is (7.3/9.0) 81 per cent of full capacity.

Note that with the variable-speed units the capacity depends upon the available horsepower of the drivers. If the horsepower characteristic of the driver permits overload at overspeed, the capacity of the system, in per cent, with one unit out of service can be maintained at an even higher percentage of full load than is possible with constant horsepower versus

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speed characteristic. This characteristic is generally obtainable from gas-engine drive but normally not from a steam turbine. In the case of a gas turbine, it is not normally obtainable unless excess temperatures are allowed for overload conditions.

It is interesting to investigate the operation of the line at very low capacities. Let us assume 25 per cent line capacity, or a flow function of 2.4 on 20-mile spacing. While the pressure loss is such that we would need a pressure ratio of only 1.087, even with 160-mile spacing, this capacity is below the surge limit of the booster and we would have to bypass some gas from the booster discharge back to the inlet. This, obviously, wastes power. It might be better to run the units at reduced speed on 80-mile spacing, thus taking less theoretical power and bypassing less gas to keep above the surge limit. This would, of course, be impractical in the case of a constant-speed unit and probably in that of a single-shaft gas-turbine unit.

Reduced Line Pressure

Another method of operation is to reduce the line pressure. If we reduce the initial line pressure from 750 to 400 psig., the flow function for a given capacity goes from 2.4 to 4.65. This would bring it into the operation range of the booster, with units running on 40-mile spacing. From this it is apparent that, even though the booster has a somewhat limited performance range, it is always possible to operate the line in a way to handle any capacity up to the maximum. However, it should be noted that when we reduce the pressure from 750 to 400 psig. the horsepower per 1,000,000 cu. ft. daily per booster is almost as much as it is at 750 psig.

Since four stations would be running on 40-mile spacing instead of one on 160-mile spacing it is easy to see that it would require less power to operate one booster, bypassing some gas, than it would to operate four boosters with reduced line pressure. This illustrates the fundamental importance of always operating the line at full pressure. In general, probably the only reason for operating the line at reduced pressure is to get temporary high capacity at the outlet end of the line to take care of short-time demand peaks.

Single Versus Multiple Units

The question whether to use single-unit or multiunit stations naturally depends upon a lot of factors among which are percentage availability, size of power units available, labor costs of closely spaced versus widely spaced stations, installation costs, site availability, etc. We will discuss only the operating differences.

Example.—Suppose we space the stations 40 miles apart and use two boosters in series instead of single boosters with 20-mile spacing.

Solution.—Taking only the 5,200-r.p.m. curve to simplify our problem, the booster develops a pressure ratio of 1.16 at this capacity. With two in series it will be approximately 1.16 × 1.16, or 1.346. Now plotting our second-stage booster curve by simply squaring the pressure ratio developed by the first stage at the same flows we see that it intersects the 40-mile line at a slightly smaller flow function, corresponding to a capacity of 640 instead of 675. This is the penalty of 40-mile instead of 20-mile spacing.

Now consider the effect if we cut out one booster. The capacity falls to 490 million cubic feet daily, which is exactly the same as that when the stations are spaced at intervals of 20 miles and one station is dropped. This is important because it illustrates that with a given number of boosters the maximum capacity of the line is greater with single than with double-unit stations, but that when any one booster is out of service the line capacity is just as high with two-unit stations as with single-unit stations.

Selecting Boosters

The problem of selecting boosters in planning a line and its gradual growth in capacity requires careful consideration. Suppose we take the example of the 28-in. line with an

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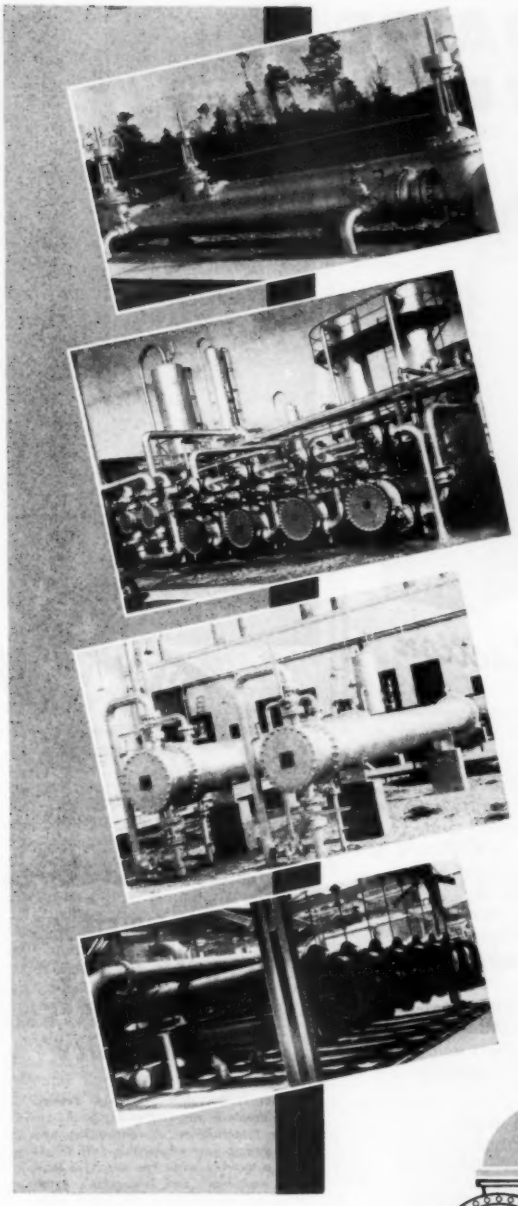

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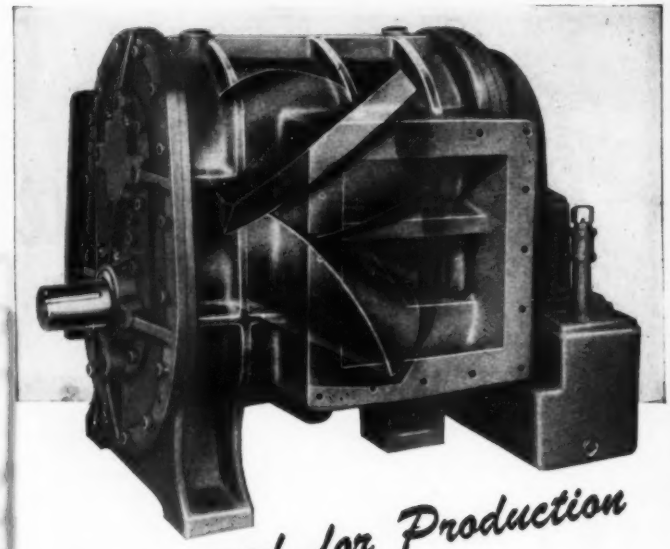

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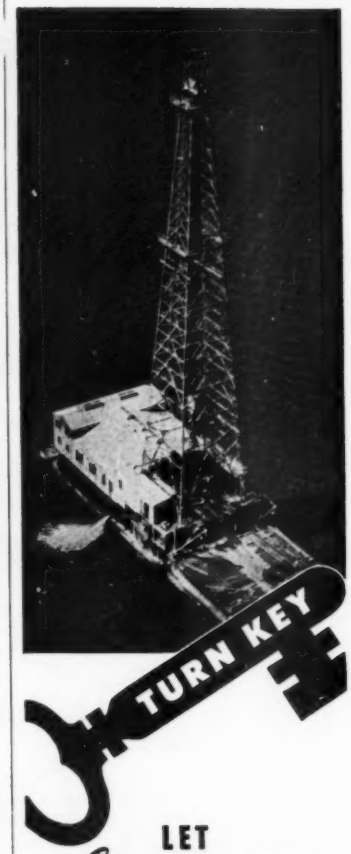

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ultimate capacity of 675 million cubic feet and 20-mile spacing of stations.

Example.—Let us assume that this line started with 250 million cubic feet and that it was to be built up to its maximum over a period of 10 years.

Solution.—At the 250 million cubic feet daily capacity the flow function is 3.52 and the pressure ratio is 1.0415 for 40-mile spacing, 1.09 for 80-mile spacing, and 1.205 for 160-mile spacing. A glance at the booster curve for the maximum conditions shows us that we could do the job with 160-mile spacing by bypassing some gas, thus wasting some power, but installing only one unit in 160 miles. Or we could also put in two units every 80 miles at a considerable reduction in power and no bypassing, provided they were of the variable-speed type. The latter would probably be second choice. A booster or boosters to meet maximum conditions would probably be the best selection if the initial operating-fuel cost is not too important and the increase in line capacity is expected to be fairly rapid. On the other hand, if the line growth is slow it might be advisable to choose a unit that more nearly suits the initial conditions, with the expectation of either replacing it as the line capacity grows or altering the initial parts. One alternative would be to install a single small-capacity unit for one of the 160-mile-spaced stations, later adding another unit in parallel to that station.

In general, parallel operation is not desirable, but it might be advisable in a case like this and would effect better operating economy at light loads. Note that one station with units in parallel gives just as good a light load performance as all the stations with units in parallel. Therefore nothing is gained in having parallel units in more than a few at the most. It would probably be advisable to have one or several reciprocating booster stations for low-capacity operating conditions so that maximum operating flexibility could be attained when it is important to get good fuel economy at light loads.

While our chart is based on one particular flow equation, it is easy to construct a similar one for different conditions or for a specific line. Our chart illustrates the general operating principles, but it might be desirable to plot one for analysis of a particular line under consideration.

To summarize the characteristics of the centrifugal booster in pipe-line operation we list the following important points:

1. Stations should have units in series rather than parallel. There are few exceptions to this rule.

2. Variable-speed drivers are required for greatest economy and flexibility of operation.

3. In planning a line the centrifugal units should generally be designed for the ultimate line capacity rather

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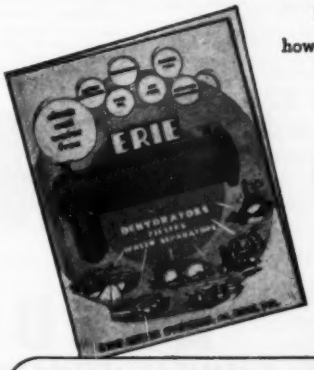

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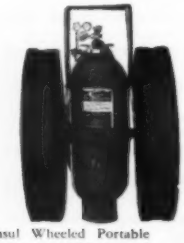

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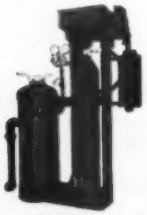

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than for initial conditions because the units can be successfully operated at part load, or to meet initial-capacity conditions.

4. By careful attention to booster and driver characteristics a unit can be dropped from service with a minimum loss in line capacity.

5. Under light-load conditions it is better to operate a line at full pressure and to maintain sufficient flow through the booster with a bypass than to reduce the line pressure.

Casing-String Design

(Continued from page 244)

sure at each point times the change in area at that point. When the greater area is in the lower section the load in the upper section is greater, and vice versa.

The net effect of buoyancy is a substantial amount, varying from about 14 per cent of the unbuoyed weight when the pipe is hanging in 70-lb. per cu. ft. mud to 20 per cent in 100-lb. per cu. ft. mud. It is felt that this effect should be included in casing-string design practice.

Tension variations in service.— Throughout its service life after cementing is started, a casing string is subjected to varying tension loads. During cementing, buoyancy of the cement will tend to decrease the load. After being landed permanently, increased internal pressure or decreased temperature will increase tensile load, while internal pressure decrease or temperature increase will have the opposite effect.

The factors involved in landing casing and their evaluation have been investigated by De Hetre[10] and by Oberg and Masters.[11] These investigations indicate that it is important to give engineering consideration to the landing of casing. Casing should be landed at the minimum load that will not cause a dangerous degree of column loading to develop at any time. For very severe anticipated temperature and pressure changes, it may be desirable to use casing with higher tension strength than would otherwise be necessary.

Fortunately, increased tension due to temperature and pressure changes after landing casing is not likely to be accompanied by shock or acceleration loading, so the tension load can safely be higher under such conditions than while running the string. Thomas and Bartok[12] found that A.P.I. joints properly made up will not leak until the tension load approaches the yield strength in the critical section of the joint near the last engaged thread. Such a loading corresponds to a tension safety factor below 1.4.

In spite of the fine work of De Hetre and Oberg, and Masters, the problem of landing casing is not well understood, and more study and investigation is needed.

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The tension loading at the time the casing is hanging free in the hole before cementing is commonly used as the basis for determining the change of collapse strength due to tension. This is a purely conventional assumption, since the casing must at least be cemented and landed before a critical collapse loading can be applied. However, it is felt that this assumption is the best available, but that the true effect of buoyancy (Fig. 6) should be included. This procedure is advocated by Curran.[10] It probably is conservative since the same condition which causes the collapse loading (reduction of internal pressure) causes further reduction of longitudinal tension. This last-mentioned tension reduction can be evaluated[9,10] and could be included in design, but the resulting calculated increase in collapse strength may not be realized because of variation in landing practice and temperature changes.

Payne[9] argues that the effects of tension on collapse strength in deep strings should be ignored because the bottom section is in compression. This does not seem to be a proper procedure, since collapse often is critical at points far off bottom where the casing definitely is in tension, and when the pipe is in compression the collapse resistance is actually increased.

Overpull to failure.—Normal design practice is to apply a uniform limiting tension safety factor throughout each string. Fig. 7 illustrates a result of this practice. Assuming that the casing at the surface and at depth **F** are loaded to the same safety factor, the casing at the surface must be stronger than at **F** as illustrated by the joint strength lines. If the string is stuck below depth **F** and pulled to failure, it will fail at depth **F** at an overpull shown as A. The total pull to failure will be less than the joint strength of the pipe at the surface. It is sometimes desirable to alter tension safety factors by making the available overpull more nearly equal at critical points.

Tension loading summary.—It is evident that for tension a dependable maximum loading cannot be calculated because of acceleration loading and possible overpulls, but the free hanging weight of the string appears to be the best basis for design.

Bursting.—Fig. 8 illustrates the factors involved in determining bursting load on a casing string. This load is equal to the excess of internal over external pressure as illustrated by differential pressure A. Diagramed at the right are casing bursting strengths capable of meeting, with a margin of safety, the condition shown by the solid pressure lines.

The external pressure opposing bursting can be zero at the surface and perhaps for some distance down the hole, but will be at least equal to fluid pressures in the formations surrounding the casing.

The maximum internal pressure from within the well itself would be caused by a hole full of dry gas at a bottom-hole pressure equal to that of the mud used to drill the producing zone. This is a severe condition not often encountered in California, and, when possible, design is based on expected shut-in casing-head pressures. Fortunately, the casing required to meet tension and collapse conditions usually proves strong enough for normal bursting loads. If a casing string is to be used for injection purposes it may be subjected to higher bursting pressures than indicated above, as illustrated by the broken line in Fig. 8.

Predicted bursting pressures may or may not be real maximums, but there is no shock loading to consider. Surface pressure on a casing string is easily measured at any time, and may be controlled to some extent.

Types of casing strings.—Table 1 lists the design considerations for the various types of strings run in an oil well. Complete design is most important for water shutoff (oil strings), but the loading conditions on the other types should be considered carefully.

It is apparent that the service conditions of liners and surface strings must be met chiefly by choice of adequate wall thickness, but protection strings may have to be designed on the same basis as water shutoff strings.

Safety factors.—Choice of these is the responsibility of the individual operator, and depends upon the amount of insurance he wishes to buy. The decision should assume sound design which will evaluate as correctly as possible the true safety factors.

Choice of suitable factors of safety in any engineering design must be based largely on the following considerations:

1. Reliability and accuracy of the strength data used for design. The closer these data approach true minimums, the smaller the safety factor can be.
2. Comparison of service conditions and test conditions used for determining strength data used for design. If service conditions impose the same type of loading as used in testing (considering impact, fatigue, etc.), this will tend to permit small safety factors.
3. Reliability and accuracy of the loading assumptions used for design. The closer these loading assumptions approach the maximum that can be encountered in service, the smaller the safety factor can be.
4. The consequences of failure. If failure would cause serious hazard to personnel or great economic loss, safety factors should be increased.

A.P.I. casing-strength data are minimum values and thus permit loadings very close to the listed strengths with little hazard of failure. However, such high loadings make it imperative that no defective material be used and make complete and careful inspection of casing very important.

When designing for collapse, the load assumed will rarely be exceeded, and is applied in the same relatively slow manner that is used in collapse testing. The consequences of failure are serious economically, but there is no hazard to personnel. Therefore, the only reason for use of a safety factor more than 1.0 is the high cost of failure, and a safety factor of 1⅛ appears ample.

When designing for tension, the load assumed is not necessarily a maximum, and acceleration loading exists. Failure would be expensive, and there is some hazard to personnel. Therefore, tension safety factors approaching 2.0 on ultimate joint strength are indicated. The factor need not be this high on yield strength of the pipe body, since yielding would not necessarily result in actual failure. A safety factor of 1.5 on body yield strength appears ample.

For bursting, maximum possible theoretical loading may or may not be assumed, failure would be expensive, and there is hazard to personnel. However, failure would result from a slowly applied load, and the strength used for design is based on yield rather than ultimate strength. Where theoretical maximum pressures are used for design, the safety factor can be about the same as for collapse, but otherwise must be higher.

Obviously, the ultimate test of the suitability of safety factors is actual application. Field experience appears to confirm that safety factors in the ranges discussed give ample safety when the conditions of wear, corrosion, etc., are considered and provided for separately.

Design Practice of California Operators

A canvass of representative California operators indicates that casing-string design is given careful consideration in the interest of safety and

TABLE 1—TYPES OF CASING STRINGS CONDITIONS TO BE CONSIDERED IN DESIGN

Service condition	Surface strings	Protection strings	Water shutoff (oil) strings	Liners
Collapse	Not normally	No, if mud level always maintained inside	Yes	No
Tension	Not normally	Yes, landing practice important	Yes, landing practice important	No
Bursting	Yes, for blowout prevention	No, unless to be used as oil string in future	Yes	No
Internal wear	Yes (drill pipe)	Yes (drill pipe)	Yes (drill pipe and tubing)	Yes (tubing)
Corrosion	Seldom	Seldom	Yes	Yes
Gun perforating	No	Not normally	Yes	Occasionally
Fatigue	Yes (drilling through)	Yes (drilling through)	Yes (drilling through)	No
Sand erosion	No	No	No	Yes

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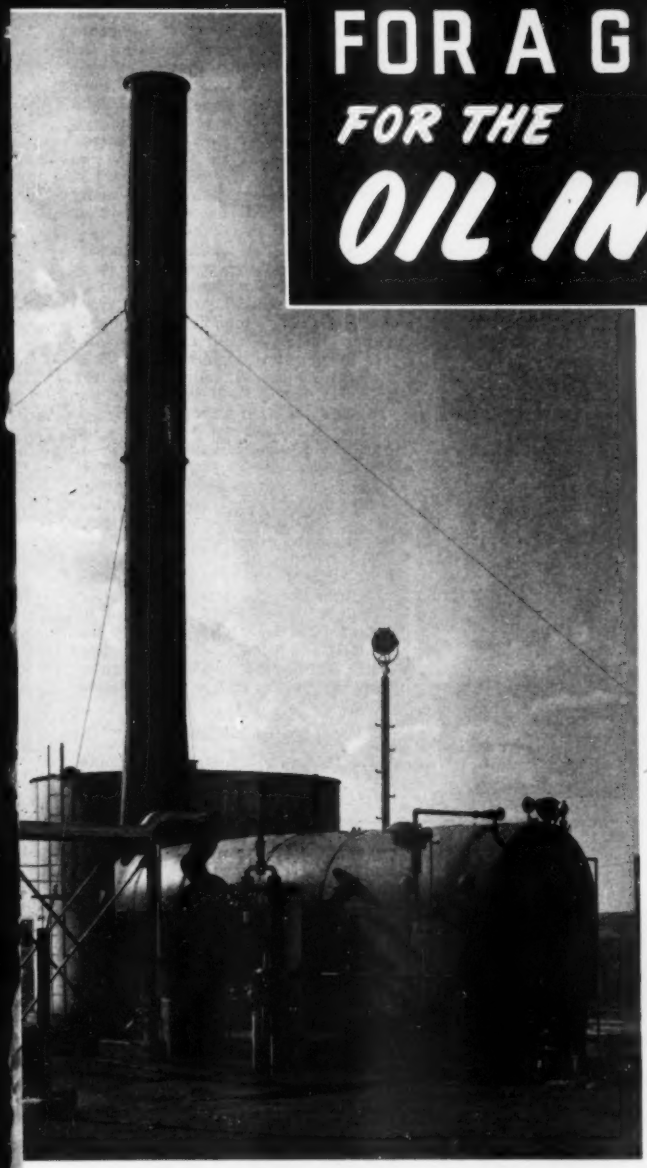

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economy. Design practice conforms generally to the principles outlined in this paper, except as regards the use of buoyancy in design. When buoyancy is considered the conventional assumption is made that buoyancy acts over the entire length of the string.

All operators canvassed base their loading for collapse on actual mud weight or formation pressure, and all make corrections for biaxial stress. Preference for collapse safety factors is about evenly divided between 1.25 and 1.125, the maximum used being 1.33. A few will go below 1.12 at the bottom of the string.

About half the operators consider the effect of buoyancy on tensile loads and these use a minimum safety factor on joint pullout strength of from 1.8 to 2.0. The other half do not calculate the effect of buoyancy and use lower safety factors of from 1.63 to 1.8. A minimum allowable safety factor of 1.5 on yield strength of the pipe body is used quite generally.

Most operators use a safety factor of about 1.50 for bursting, but practice varies from 1.10 to 1.75. This large variation is due partly to differences in loading assumption. Also, bursting pressures are seldom critical in design and generally have not been given much study.

Practically all operators consider wall thickness an important criterion and do not necessarily run the minimum casing weights indicated by the nominal safety factors. For instance, many will not run 7-in. casing lighter than 26 lb. per ft. in combination strings.

Design Procedure

The first step in design is to choose the safety factors, the loading conditions, and any limitations desired such as minimum wall thickness, minimum length of sections, maximum number of sections, etc. Throughout the design, conformance with all these factors must be maintained.

The next step in all design procedures must be the choice of pipe to meet the collapse loading at the bottom of the hole. It is essential to start at the bottom because the design for tension and corrections for biaxial stress are affected by the weight below each section considered. The pipe chosen for the bottom is continued upward until the collapse loading has decreased sufficiently to allow use of a lighter weight and/or lower grade. At this and subsequent changes, corrections must be made for the effect of biaxial loading.

Proceeding upward, the process of changing to a weaker pipe as permitted by the collapse loading is continued until tension or bursting becomes the limiting condition. Increasingly strong pipe, with allowable strengths sufficient to meet both tension and bursting loadings, are chosen for the top sections. Here, many combinations of weights, grades, and

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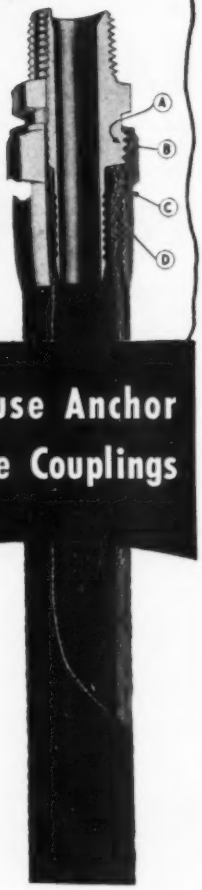

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joints are possible, but greatest economy usually results from choosing high-strength joints on light weights and low grades.

It is desirable that the method of design be as simple as possible. However, it should not restrict the choice of safety factors, loading conditions, kinds of pipe and joints, or other design assumptions. Direct step-by-step mathematical methods, although not basically difficult to understand and apply, are time consuming and involve a great deal of cut-and-try computation. This is especially true if an attempt is made to compare various possible combinations of pipe in the string. A complicated or tedious procedure discourages search for the best design, and encourages the use of oversimplified assumptions.

A graphical method developed by W. C. Main and published in the information booklet of a pipe manufacturer[14] appears to be the best casing-string design method available at present. It has the following advantages:

1. Any desired mud weights, safety factors, and design assumptions can be used, and trials of various combinations of weights, grades, and joints can be made easily.
2. Even a rather complicated string can be designed in 15 minutes.
3. For each size of casing, all the necessary strength data can be on the design chart.
4. The finished design can be checked readily.
5. Relatively inexperienced personnel can learn to use the method quickly.

This method is illustrated by Fig. 9 for 7-in. o.d. casing. A separate chart is needed for each casing size.

This design chart provides:

1. A means of determining graphically the collapse loading in terms of mud weight and collapse safety factor. (The left-hand section of the chart.)
2. A graphical representation of the variation of casing collapse resistance with longitudinal tension load. (The right-hand section of the chart.) The curves on this section are derived from the curve shown in Fig. 2 (effect of biaxial stress).
3. Plotted points on the collapse strength curves showing allowable tension loads for various joints.
4. A means of constructing a tension load vs. depth curve of the type shown in Fig. 5. (Tension analysis.) The choice of casing for the string is made when this curve is plotted.

More detailed comments on the design chart and an example of design (Fig. 11) are included in the appendix.

This chart can be simplified to almost any extent desired, although simplification sacrifices flexibility. If only one collapse safety factor is to be used, this factor can be incorporated in the mud-weight scale and mud weight can be used directly. If only one safety factor and one mud weight are to be used, the entire left portion of the chart becomes a single vertical line graduated in depths, and the construction of the tension load vs. depth curve is simplified.

With all conditions fixed, the chart will become identical to the type described by Cooley[15,16] and illustrated by Fig. 10. It is very simple to apply, but almost no variations can be made from the assumptions on which the chart is based.

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APPENDIX

Construction of Design Chart

A more complete explanation of construction of the design charts shown in Figs. 9 and 11 is available in the informational booklet of a pipe manufacturer. Fig. 9 is essentially the same chart as shown therein with modifications as follows:

1. The curves of collapse strength vs. tension load have been extended into the region of compression.
2. The steep right-hand sections of these curves are corrected for 1.125 collapse safety instead of 1.25.
3. One type of high-strength joint has been added.
4. A.P.I. bursting yield strengths have been tabulated at the lower right-hand corner of the chart.
5. The line used for origin of slope points is separate from the left-hand graph, and is marked with S at its top.

Example of Design

The following example (see Fig. 11) will illustrate the use of this design chart and can serve as general instructions since all designs will follow the same procedure.

Conditions:

Size—7-in. o.d., depth 13,500 ft.

Collapse loading—Equivalent to 75 lb. per cu. ft. mud (10 lb. per gallon).

Bursting loading—4,500 psi. to 2,000 ft. decreased by external pressure of 72-lb. per cu. ft. mud (0.5 lb. per ft.) from 2,000 ft. to bottom.

Safety factors:

Tension—2.00 on A.P.I. joint strength, 1.5 on minimum yield of pipe wall.

Collapse—1.125 on A.P.I. collapse strength except may approach 1.0 at bottom.

Bursting—1.50 on A.P.I. internal yield pressure.

1. Draw vertical "Program Line" (1) at $(75 \times 1.125) = 84.5$ on mud weight × safety factor in collapse scale. This line becomes the depth scale for design.

2. Locate air-weight slope point S_A by drawing a horizonal line (2) from the 10,000-ft. depth point on the program line to the slope point line.

3. Locate buoyancy slope point S_B as follows: From intersection of curved buoyancy line and actual mud weight (A) move parallel to slanting depth lines (3) until program line is reached. Then move horizontally (3) to slope point line at S_B.

4. Draw horizontal line (4) from 13,500 ft. (total depth) on program line to zero tension load (Point C). This indicates that 32-lb. N-80 probably will be satisfactory at the bottom of the string.

5. Determine compression in pipe at bottom as follows: From C draw a line (5) paralleling S_B-32 to Point D at top of chart. Then from D draw line (5) paralleling S_A-32 to E on Line 4. CE represents the buoyant force on the bottom of the 32-lb. pipe, and E is the point from which the design load starts. This point may be calculated as follows, in which case the "buoyancy line" is not needed. Area of 32-lb. pipe = 32/3.4 = 9.4 sq. ft.

$$\text{Pressure at 13,500 ft.} = \frac{13{,}500\ (75)\ (0.433)}{} = 7{,}020 \text{ psi.}$$

Compression load = 9.4 (7,020) = 66,000 lb. = CE

(Note that the nominal pipe weight is used to compute pipe area, which results effectively in unit tensile stresses being calculated 1.8 per cent low, which is considered negligible.)

6. Check actual collapse safety factor at bottom as follows:

Actual pressure at 13,500 ft. = 7,020 psi.

Collapse strength of 32-lb. N-80 corrected for compression of 66,000 lb. is 7,700 psi. (see Line 6).

Collapse S.F. = 7,700/7,020 = 1.09, and is satisfactory.

7. Draw a line (7) through E paralleling S_A-32 and passing through the 29-lb. N-80 line a short distance. Starting near this crossing (10,600-ft. depth) 29-lb. N-80 can be used. Since there will be a (32 — 29)/3.4 = 0.88 sq. in. area change with the lighter at that point by 0.88 × mud pressure at 10,700 ft., and 0.88 × 5,500 = approximately 5,000 lb. Locate Point F on the 29-lb. N-80 line at 5,000 lb. tension load to the right of the line (7) just drawn upward from E.

8. From F draw a line paralleling S_A-29 and proceed as in Step 7, establishing Point G above which 26-lb. N-80 can be used.

9. From G proceed similarly, establishing Point H above which 23-lb. N-80 can be used.

10. From H draw a line (10) upward, paralleling S_A-23.

11. At this time the factors of bursting and tension must be considered. From tabulation at the lower right, A.P.I. bursting yield strength of 23-lb. N-80 is 6,340 psi., and allowable working pressure with 1.5 S.F. is 6,340/1.5 = 4,200 psi. From the bursting load assumption, 4,200 psi. differential pressure will occur at 2,600-ft. depth.

Interval	Length	Size	Weight	Grade	Joint	Safety factor—C	Safety factor—T	Safety factor—B
0- 2,600	2,600	7	26	N-80	High strength	High	2.03	1.60
2,600- 5,800	3,200	7	23	N-80	High strength	1.125	2.26	1.50
5,800- 8,200	2,200	7	26	N-80	Long T&C	1.125	2.88	High
8,200-10,600	2,600	7	29	N-80	Long T&C	1.125	High	High
10,600-13,500	2,900	7	32	N-80	Long T&C	1.09	High	High

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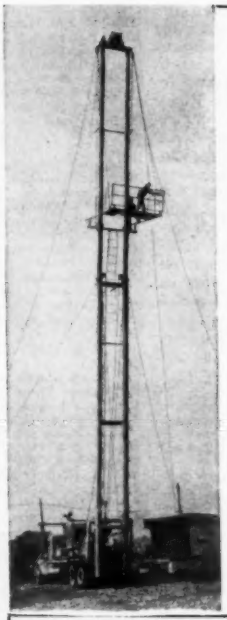

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Draw horizontal line (11) from 2,600-ft. depth on program line to intersect line (10) coming up from H. Above this point (J), 26-lb. N-80 must be used to meet the bursting requirements. From the allowable joint loads shown on the 23-lb. N-80 line, it can be seen that both long and short regular A.P.I. joints have allowable loads less than the 240,000-lb. load at Point J but the high strength 23-lb. N-80 joint at 270,000-lb. allowable load will be satisfactory.

12. At J make tension correction for area change which will be negative since the higher weight is on top.

$$\frac{0.88 \times 2{,}600 \times 75 \times 0.433}{62.4} = 1{,}200 \text{ lb.}$$

reduction in tension load.

13. From the corrected Point J draw a line (13) upward paralleling S_A-26 to intersect the top of the chart at K.

14. The tension load (at Point K) is 311,000 lb. The 26-lb. N-80 LT&C high-strength joint plotted has an allowable load of 312,000 lb. and, therefore, is satisfactory.

15. Draw horizontal lines (15) from F, G, and H to program line.

16. At the points of intersection L, M, N, P of lines 15 and 11 with the program line, read the depths of the changeover points.

17. Record these depths in the casing program column at the left of the chart, together with the length and specification of each section.

The program, assuming long-threaded and coupled joints throughout, is then as shown in the accompanying table.

It happens that in this string the overpull necessary to stress the three top sections to their minimum ultimate joint strength is very nearly the same in spite of the 2.26 and 2.88 minimum safety factors in the lower two of these sections.

Landing practice.—De Hetre's equations for changes of load due to temperature and pressure changes in casing are as follows:

1. Temperature change:

$$P = 58.2\ W\Delta T$$

where

P = change in load at landing head (lb.)
W = nominal pipe weight (lb. per ft.)
ΔT = average temperature change of free casing (°F.)

A temperature drop results in an increased load, while a temperature rise results in a decreased load.

2. Pressure change:

$$P = 0.0434\ W\Delta P\ D/t$$

where

P = change in load at landing head (lb.)
W = nominal pipe weight (lb. per ft.)
Δp = average net pressure change in free pipe (psi.)
D = casing outside diameter (in.)
t = casing wall thickness (in.)

When the net pressure change is an internal increase, the change of load at the landing head will be an increase. When the net pressure change is an internal decrease, the change of load at the landing head will be a decrease.

Bursting pressures.—The following approximate formula can be used to calculate the maximum surface pressure in a well full of dry gas at a known or assumed bottom-hole pressure.

$$P_S = \frac{P_B}{1 + 0.02D}$$

where

P_S = pressure at surface, lb. per sq. ft.
P_B = bottom-hole pressure, psi.
D = depth, thousands of feet.

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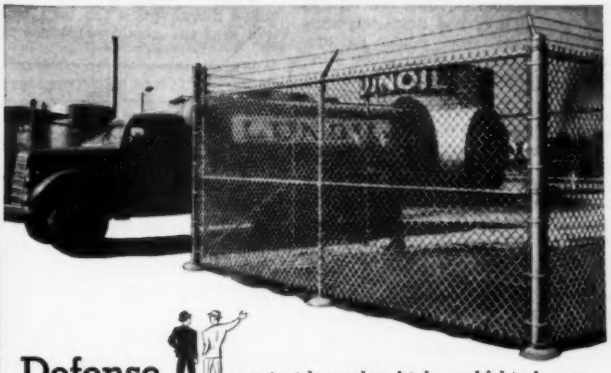

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Graphite Rod and Ground Beds

THE problem to be solved in the design of a graphite-rod ground bed is that of selecting the proper number of rods, at the proper spacing, to combine to form a bed whose resistance is such that the total annual cost shall be a minimum. A high-resistance bed requires an excessive amount of power; a low resistance bed may require too much original investment. In the following described procedure, it will be assumed that there is a given amount of current to be drained from the line at a particular site, both of these variables having been fixed by the over-all design of the cathodic protection system. The site chosen will be one having the lowest-resistivity soil available in the vicinity, and will be assumed to have power available.

The first step is a tentative selection of the number and size of rods to be used. Installed in the correct backfill, 80-in. rods may be operated up to a total current per rod of 1.75 amp. per inch of rod diameter; thus a total of 35 amp. could be discharged through ten 2-in., seven 3-in., five 4-in., or three 6-in. rods, without exceeding the rated capacity of the rods. It does not follow that just this number of rods can be used.

We next turn our attention to the soil resistivity; as a first approximation, let us assume that the soil is uniform to great depth; we use the value obtained with 10-ft. spacing of the four electrodes of the resistivity apparatus. The resistance to earth of a single rod in tamped coke backfill three rod diameters in diameter is given by

$$R = \rho K,$$

where ρ is the soil resistivity in ohm-cm, and K is a constant having the value of .0024 for a 2-in., .0022 for a 3-in., .0020 for a 4-in., and .0017 for a 6-in. rod. Thus if our site has 4,000-ohm soil, we should have resistance equal to 9.6, 8.8, 8.0, and 6.8 ohms respectively; to discharge the full rated current through each size rod in such soil would require voltages of 33.6, 46.2, 56.0, and 71.4 volts respectively; all of these values are too high; power costs would be excessive. Had we had 800-ohm soil, the choice might have been between ten 2-in. rods at 6.72 volts and seven 3-in. rods at 9.24 volts; a comparison would have to be made to balance the higher power costs of the latter with the lower first cost.

Actually, the last example represents an oversimplification for the resistance of 10 rods in parallel is more than one-tenth the resistance of a single rod; now much more depends not only on the spacing of the rods, but on the variation of soil resistivity with depth. If the soil is approximately uniform, the curves shown in Fig. 1 may be used; if the resistivity increases with depth, the "crowding" effect will be greater, while if it drops off markedly with depth, the anodes will not affect each other so much.

Another oversimplification in the above discussion is the tacit assumption that the anode resistance represents the entire resistance to be overcome; although it is true that the major portion of the resistance of the cathodic protection circuit is in the soil immediately adjacent to the anode, this is never all of it. Usually, the addition of about 2 volts to the value as obtained above will give the actual figure needed. Thus we can obtain a first approximation to rectifier requirements and power consumption, for anode beds consisting of the various sizes of rods, at the particular site under consideration.

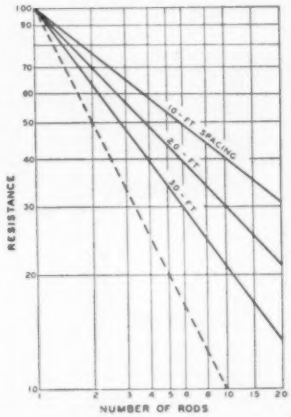

Fig. 1—Resistance of multirod ground beds in terms of percentage of resistance of single rod. Dotted line indicates theoretical curve for infinite spacing.

The next step, if the soil resistivity is 2,000 ohms or more, is to evaluate the possible savings which could be obtained by extending the ground bed, so as to reduce the load per rod below its normal rating. This will reduce the total resistance and thus lessen the power consumption. To make this comparison it is necessary to consider the installed cost of the additional anodes and the power rates, both of which are subject to considerable variation according to the location.

One more major calculation remains to be made, dealing with the choice of cable size; the installed cost of the cable must be compared with the cost of the power loss in the cable; this comparison involves the cost of copper and of power. Because of the fact that it may become necessary in future years to enlarge the ground bed, because of increased current demand as the line coating deteriorates, it is better to err on the conservative side, and install a somewhat larger cable than called for by the comparison.

It is also sound practice to install a rectifier of greater capacity than indicated by the original estimate, if more current is needed, the ground bed may be extended. If more current is needed temporarily, as is often the case during prolonged dry weather, the voltage of the rectifier may be increased; this plan is particularly adapted to a design in which the anodes are not carrying their full rated current under normal conditions..

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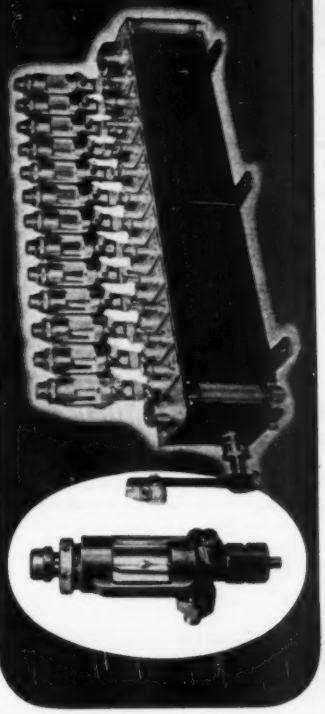

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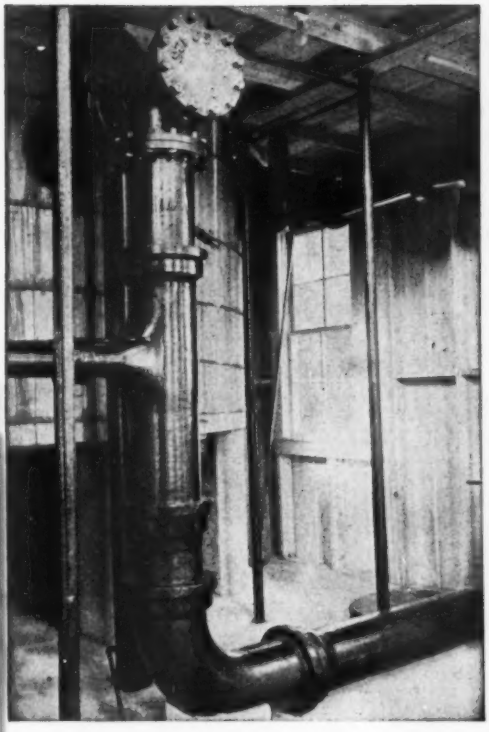

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Centrifugal Compressors Operating Economically

(Continued from page 248)

1 is the oil consumption for each unit. The oil consumption averages about 1 gal. per 75,000 hp. hours.

A mechanical problem related to the use of turbocompressors at Seeligson is the operation of the steam plant. The centrifugals under full load require approximately one-third of the steam generated at the plant, the remainder of the steam being consumed in the process portion of the plant.

Costs.—The segregation of costs chargeable against isolated pieces of equipment in a complex plant is quite difficult. In addition to the direct expenses which can be ascertained against the equipment, there are numerous indirect and mutual service charges.

Operating Economics

Because of the newness of the centrifugal compressor application at Seeligson, an attempt has been made to keep fairly accurate records of expenses chargeable against the operation of these units. Table 2 recaps the 1950 annual operating expenses in terms of dollars per turbine horsepower per year. The direct expenses total $0.56 per horsepower per year. The indirect expenses total $11.08 per horsepower per year. The total cost of $16.92 per horsepower per year represents about as good a total cost figure as normal intra plant accounting can segregate. It might be of interest to note that the figure of $16.92 compares with a preinstallation estimate of $19.58 per horsepower per year. The preinstallation estimate used 9 per cent fixed charges and when these fixed charges are made equivalent at the rate of 6 per cent, the preoperation estimate becomes $16.12 per horsepower per year.

Centrifugal vs. Reciprocating

One logical criticism that has been made of the centrifugal compressor application versus reciprocating compressors is the increased fuel consumption due to the lower efficiency of the centrifugal unit. On most applications studied by the writer, it has been found that the sum of fuel and lubrication cost is about the same for either centrifugal or reciprocating pressure. In other words, the higher fuel consumption is about offset by the phenomenally low oil consumption.

The Seeligson installation has not been in operation for a long enough period of time to prove that the centrifugal compressors will operate cheaper than reciprocating compressors at the Seeligson location. It does appear that the original estimates which did show a worth-while saving for the centrifugal installation have not been proved erroneous.

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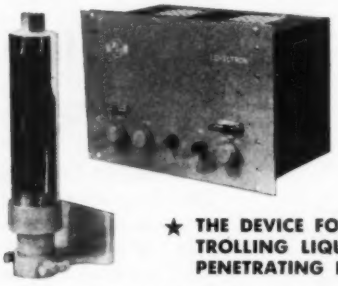

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QUESTIONS on TECHNOLOGY

by W. L. Nelson
Consulting Engineer

Grease Spoils Oil For Re-refining

Companies in the United States that manufacture re-refining equipment, all insist upon one thing, and that is that the motor-oil drainings must be kept apart from greases and especially gear oils. Is there any lube re-refining equipment that will handle mixtures of used lube oil, greases, and gear oils? H. S. S.

Questions on the subject of reclaiming lubricating oils have been answered repeatedly on this page, the latest being in the issue of March 31 and April 7, 1949.

Although it is quite possible to make lubricating oils by re-refining that are the equal of the lubricating oils produced directly from crude petroleum and from the mixed stocks that are accumulated in filling stations, such operations are probably not conducted anywhere because the re-refining operations are too complicated. To completely re-refine filling-station mixtures involves the same operations as those conducted in a petroleum refinery, and it is obvious that a refinery operating at a large capacity (500 bbl. per day to even 10,000 bbl. per day of lube oils) can produce oils much more cheaply than reclaiming plants of small capacity (10 to 200 bbl. per day).

Even the apparently free charge stock for reclaiming operations is not really free. The collection of large quantities of drainings costs at least $1.50 to $2 per barrel whereas the reduced crude oils used in regular refineries seldom costs as much as $3 per barrel. This difference in price of charge stocks is not large enough to justify large expenditures, and will not compensate for the greater costs of small scale operations.

There are, however, certain successful re-refining establishments but in every instance their success is due to special considerations. If wax-bearing draining can be eliminated, the costly operation of dewaxing can be avoided. This department knows of no standard re-refining equipment that practices dewaxing. If gear oils (corrosive sulfur additives) and greases can be eliminated from the feed stock, then both dewaxing and acid treating can be eliminated from the re-refining operations. With these two operations eliminated, it is then possible to employ somewhat simple operations of mechanical filtration and adsorbent filtration; and most of the commercial re-refining operations are of this simple type.

About the only way that charge stocks that are free from gear lubes and greases can be had is by operating the re-refining plant in connection with some very large trucking, bus, taxicab, or air-field establishment where all drainings are made and segregated by an agent of the re-refining plant.

If mixed drainings, whose source is unknown, are to be processed, it is necessary to conduct all of the following operations:

1. Mechanical settling and filtration.
2. Distilling or steaming for the removal of volatile materials, such as parts of the gasoline.
3. Vacuum distillation to eliminate residual, asphaltic, or polymerized materials as a residue.
4. Dewaxing by dilution with a solvent, refrigeration, wax filtration, and redistilling for the recovery of solvent.
5. Acid treatment followed by clay contacting and filtration, or solvent extraction or adsorbent filtration to improve the color and stability.
6. Replace additive agents that have been removed.

Probably no commercial reclaiming equipment provides for operations 3 and 4 or for the acid treatment mentioned in operation 5. Thus, none of the commercial equipments can remove wax or the corrosive sulfur additives found in some gear oils.

Plants employing the six operations listed above could be built by many consultants or engineering contractors but the cost would be excessive unless a capacity of 200 to 500 bbl. per day could be made available. Even such capacities are too small except in certain isolated or perhaps foreign regions.

References to Crude-Oil Emulsions

We should be pleased to receive any information or references regarding crude oil emulsions or the treating of them.—W. J. L.

The major references since 1937 regarding crude-oil emulsions or dehydration are listed here. So many strange and baffling behaviors are encountered in the dehydrating or desalting of crude oil that only the grossest generalities can be stated. These generalities have been outlined in the third edition of Petroleum Refinery Engineering (McGraw-Hill Book Co., Inc., New York, 1949) or in The Refiner's Notebook (No. 30), *The Oil and Gas Journal, February 17, 1945, page 121.* Although desalting and settling troubles are perpetual, specific information is so scant that each settling operation must be approached as a new problem.

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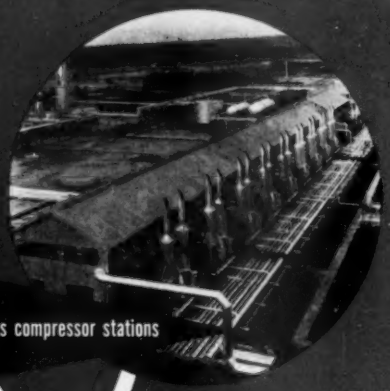

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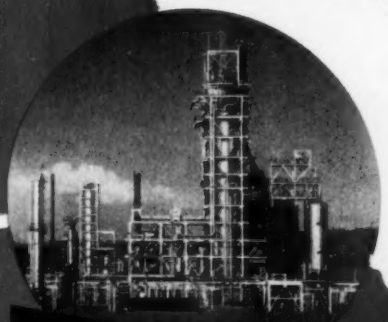

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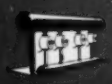

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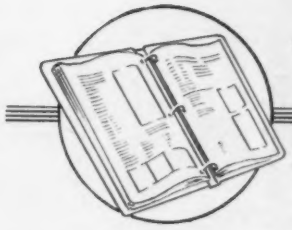


THE REFINER'S notebook

No. 81

Factors Affecting Throughput in Cat Cracking

by P. M. Reynolds*

Part 5—Economics of Product Distribution

OTHER than gasoline and light gases, cracked gas oils or "catalytic cycle oils" are the remaining product yields from the catalytic cracking operation. The light gases are routed into the refinery fuel-gas system and the isobutane and olefin hydrocarbons may be alkylated or polymerized into high octane gasoline. The lightest fractions of the cycle oil may be blended into burner and stove distillates and the heavy cycle oils may be cracked to gasoline by thermal cracking.

*Process engineer, Mid-Continent Petroleum Corp. Paper presented at second annual John Zink Process Heating Seminar, Tulsa.

To balance available feed against possible products is the major problem of the refiner. It is usually advisable to feed all clean cracking stocks through a catalytic unit maintaining maximum coke burning at all times. This sometimes means that low conversion must be maintained and large volumes of cat cycle oils produced to be further handled on a thermal unit. Highest yields are obtained in this manner by catalytic cracking first. Higher octanes and less No. 6 fuel oil are produced.

The price of burner fuels and gasoline has an important bearing on the split up of the cycle oils into burner fuel and thermal cracking charge. Fig. 1 shows the distribution of cycle-oil products between "Per Cent No. 2 Burner in Cycle Oil" and "Total Product Value" without considering costs for 15,500 bbl. per day cat cracking charge capacity. In all cases shown, as much No. 2 burner oil as possible should be split out of the cycle oil since the value of the burner fuel is higher than the value of thermal cracking charge. In fractionating the No. 2 burner, the limit is usually determined by the pour point of this cut. In most cases the No. 2 burner yield doesn't get above 50 per cent of the cycle-oil fraction but when employing favorable feed stocks and operating conditions this is sometimes possible.

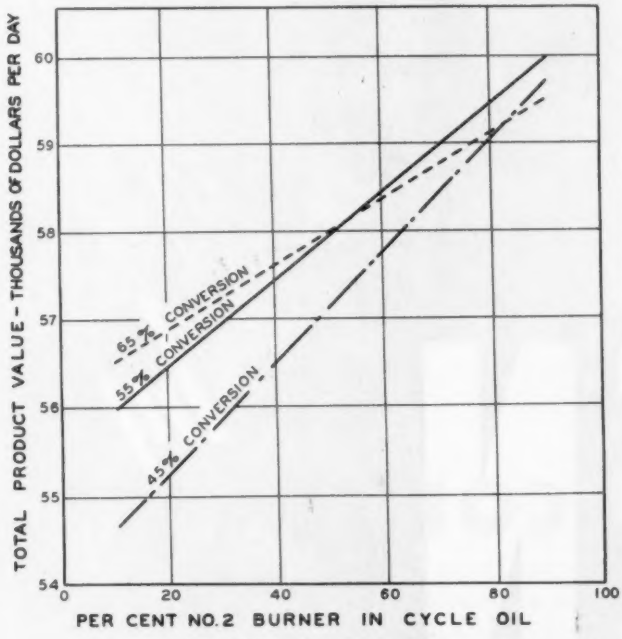
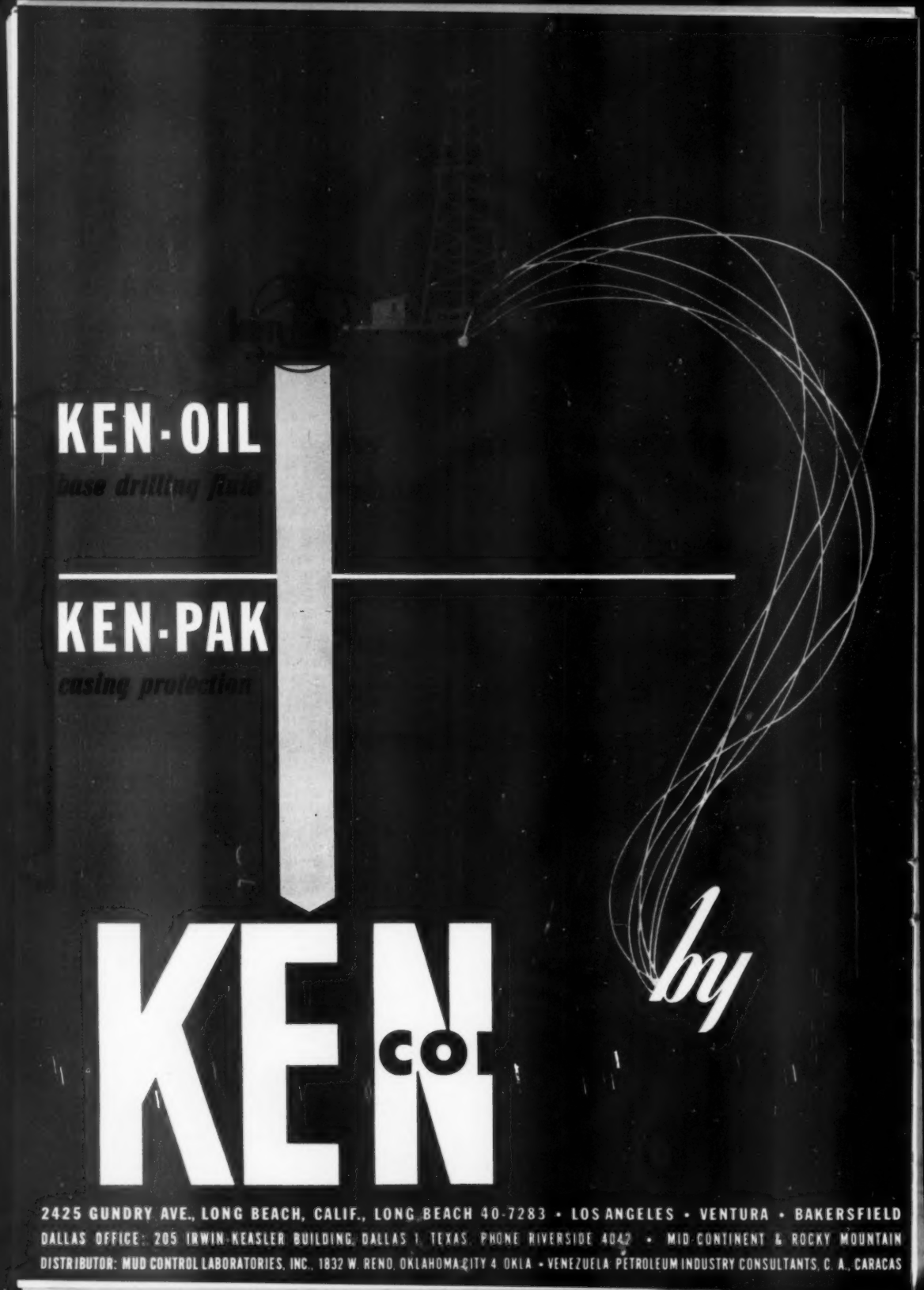


Fig. 1—Cat cracking product value.

This graph also shows that it would be best to operate at 65 per cent conversion if up to 50 per cent of cycle oil could be sold in No. 2 burner fuel. However, if a large No. 2 burner yield were possible, then conversion should be dropped to about 55 per cent and a larger fraction of cycle oil be sold as No. 2 burner fuel. The slope and position of these lines change as the prices change for each product. Operating on the right-hand side of this graph is one of the rare cases when maximum coke laydown rate should not be maintained on a cat cracker. This would open the way for more cat cracking feed if the price of No. 2 burner stayed up and if it were possible to make a large yield of No. 2 burner for long enough periods of time to warrant operation on the right side of the graph.

The addition of catalytic cracking to modern processing has offered more flexibility in petroleum refining. In doing so it has opened the way for each refiner to make the most profit possible by varying his products to meet the highest market demands. This may be done by considering the equipment on hand, by visualizing the charge stocks available, and by evaluating properly the optimum product distribution.



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Production Time Decline Curve for a Gas Drive

IN previous articles it has been shown that a gas drive can be represented by certain empirical curves which have a theoretical background in the relative permeability relationship (see Engineering Fundamentals Nos. 356-359). The discussion was made for a single homogeneous bed, but the technique can also be extended to a reservoir which is not homogeneous in permeability. The technique may, in fact, represent a method for averaging relative permeability data throughout a reservoir. As a preliminary to the application of the method to reservoirs having a heterogeneity of permeability it is necessary to develop an expression for the production time decline for a gas drive in a uniform bed.

A single uniform rock bed under gas drive (the assumptions being a constant pressure operation and a constant rate of gas injection) should perform according to the following set of equations:

$$\log (R - r)_t = \log (R - r)_{t_o} + b\beta C \quad (1)$$

$$\log Q_t = \log Q_{t_o} - b\beta C \quad (2)$$

$$\log (V + \text{const.}) = \log \text{const.}' + b\beta C \quad (3)$$

$$R_t = R_{t_o} + b\beta V \quad (4)$$

where the nomenclature is as given below.

There can be developed an expression for the rate of oil production as a function of time through the use of Equation 2. Differentiating this equation with respect to time yields:

$$\frac{dQ_t/dt}{Q_t} = -b\beta \frac{dC}{dt}$$

But, it may also be noted that the cumulative oil is related to the production rate by:

$$C = \int_{t_o}^{t} Q_t \, dt \quad (5)$$

When this equation is differentiated it is found that dC/dt is equal to Q_t. Substituting this in the differentiated form of Equation 2 gives:

$$\frac{dQ_t}{dt} = -b\beta \, Q_t^2$$

which can be rearranged and integrated, thus:

$$\int_{t_o}^{t} dQ_t/Q_t^2 = -b\beta \int_{t_o}^{t} dt$$

The integration gives (remembering that β is a constant because of the assumed constant pressure operation):

$$1/Q_t - 1/Q_{t_o} = b\beta \, (t - t_o) \quad (6)$$

This shows a linear relationship between the reciprocal of the producing rate and time. Several published sources show plots of field data according to this relationship to the linear.[1,2] The data shown here in Fig. 1 as an example are from Reference 3. The linear trend of Equation 6 is evident over the initial gas injection period but does not remain linear due to change in operating conditions.

Ordinarily, decline of production rate with time is given on some type of logarithm paper. Equation 6 can be rearranged as follows to show the logarithm form:

$$-\log Q_t = \log (t + \text{const.}) + \log b\beta \quad (7)$$

One could infer from this that theoretical grounds exist for expecting the production decline curve on gas drive reservoirs to plot as a log-log decline when shifted. It is much simpler, however, to attempt an extrapolation of decline as indicated by Equation 6 or Fig. 1.

Equation 6 indicates that the decline of production rate with time is controlled by the value of "b." This means that a variation is to be expected between reservoirs when relative permeability properties are different but not when permeability itself is different. Thus, Fig. 2 would represent the change in oil rate versus time for various beds of different permeabilities but having the same values of "b" and of formation volume factor.

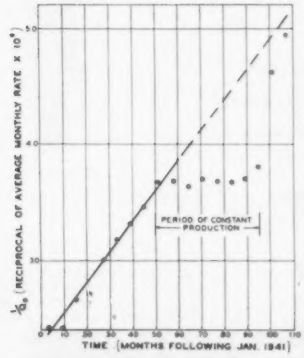

Fig. 1—Example of gas-drive decline. (Data from Reference 3.)

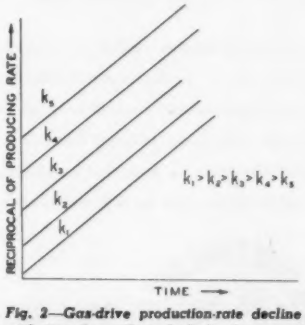

Fig. 2—Gas-drive production-rate decline with time for uniform beds having equal relative-permeability properties but different absolute permeabilities.

Nomenclature

- R = instantaneous producing gas-oil ratio
- r = solution gas-oil ratio
- C = cumulative oil production per unit of pore volume
- Q = rate of oil production per unit of pore volume
- t = the subscript denoting any time
- t_o = the subscript denoting time zero
- b = the constant in the equation $k_g/k_o = ae^{-bS}{}_o$
- V = the cumulative volume of gas injected or produced per unit of pore volume
- β = the formation volume factor

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3. Tarner, Evans, and Kaveler, The Schuler Jones Sand Pool; Nine Years of Unitized Pressure Maintenance Operations, Petroleum Technology, April 1951.

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NATURAL GAS

Railroad Commission Rules Out Uniform-Flow Schedule

AUSTIN.—The Texas Railroad Commission last week threw cold water on a proposed uniform-flow schedule as a means of reducing flaring of oil-well gas in West Texas. *(The Oil and Gas Journal, June 21, page 354).*

Commissioner William J. Murray flatly told oil operators gathered at the monthly crude-oil allowable hearing here that "we can't order a uniform-flow schedule," but added that he was planning to hold a series of conferences at Midland with the producers "to work it out."

The commissioner acknowledged, however, that one of the reasons for flaring is "the failure to produce oil and consequently casinghead gas—on a uniform schedule through the month and throughout the day."

During June, C. C. Cragin, vice president of El Paso Natural Gas Co., told the commission that "we could take as much as 50 per cent more gas, if well operators would produce gas uniformly."

Marketed Gas Production In Texas Gains in April

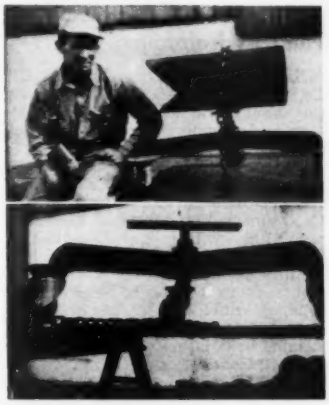
AUSTIN.—Marketed production of natural gas in Texas is running way ahead of last year.

Figures for April just released by the Texas Railroad Commission show that transmission lines took 25.6 per cent more than they did in the same month a year ago, and that consumption by carbon-black plants was up 23.61 per cent.

Other gains in gas usage were shown for plant fuel and lease use, gas lifting, and recycling. Only pressure maintenance and repressuring operations showed a decline.

Total production of gas during April was 378,119,870 M.c.f., an increase of 15.62 per cent over the same month in 1950.

Details of April's production and disposition of gas are shown in the accompanying table.



Work Saver

An old and arduous chore—handling heavy steel tubes on meter runs—has been eased at Tennessee Gas Transmission Co.'s Catlettsburg, Ky., Station 14 by development of this meter tube "inspection pack." The dolly, designed by C. B. Thompson, District 14 pipe-line superintendent, simplifies the exacting task of removing or replacing the 1,700-lb. tubes in sales and purchasing meter stations. Welder in the upper photo is Sam Curnutte, of Station 14.

Several Gas Firms Are Seeking Increased Rates

A number of natural-gas companies are seeking approval from regulatory bodies for increases in rates for service, citing rising operational costs which make more revenue imperative.

The Federal Power Commission began hearings in Washington, D. C., last week on the proposal of Northern Natural Gas Co., Omaha, to raise rates $9,300,000 annually. The increase has already been allowed to take effect, but is subject to the company's posting of a bond and the possible refund of any portion of the increase which the commission subsequently found not to be justified.

FPC announced hearings of Mississippi River Fuel Corp., St. Louis, which seeks a proposed $3,100,000 annual rate increase which would affect eight of the firm's interstate wholesale customers, will reconvene September 5 in Washington, instead of on July 16 as previously scheduled. The commission on July 10 denied a motion by the firm requesting permission to make its proposed increase, now under FPC suspension, effective for all gas billed after June 1, 1951.

In Oklahoma, the Oklahoma Gas & Electric Co. is considering asking the State Corporation Commission for a rate increase. Oklahoma Natural Gas Co., Tulsa, has already asked the commission for a $6,906,000 annual rate increase.

Pennsylvania Senate Climbs On Gas-Storage Bandwagon

HARRISBURG, Pa.—The Pennsylvania Senate passed a bill by 29 to 14 last week which would allow natural-gas companies to acquire abandoned wells for use in storing natural or manufactured gas underground.

The measure, giving companies the right of eminent domain in taking over the wells, excludes coal mines and wells near coal mines.

It was sponsored by Sen. A. Evans Kephart (R-Philadelphia) and will now go to the house of representatives.

ULTIMATE DISPOSITION OF ALL GAS PRODUCED IN TEXAS, APRIL 1951
(Source: Texas Railroad Commission)

	M.c.f.	Per cent of total	Per cent of increase over April 1950
Extraction loss—plants*	14,008,473	3.71	19.64
Plant fuel and lease use	30,584,046	8.09	9.92
Gas lift	13,743,040	3.63	24.22
Pressure maintenance and repressuring	22,567,576	5.97	—10.72
Transmission lines	214,704,802	56.78	25.60
Recycled	48,562,393	12.84	1.60
To carbon-black manufacturing	30,452,103	8.05	23.61
Vented and line loss	3,497,437	.93	57.42
Total	378,119,870	....	15.62
Net total for market	306,989,901	....	23.59

*Extraction loss is shrinkage in gas volume due to removal of liquefiable hydrocarbons.

Natural Gasoline

L.P.G. Booklet Describes New Test Specifications

Two new L.P.G. test methods and altered specifications on other tests are contained in a new publication released recently by the Natural Gasoline Association of America, Tulsa.

The new methods are the L.P.G. Corrosion Test and the L.P.G. Sampling Method. The 32-page booklet, N.G.A.A. Publication 2140, also includes a former separate publication, "L.P.G. Specific Gravity Test (Hydrometer Method)."

Adopted as recommended procedures at the June meeting of the N.G.A.A., the new tests and revisions in previous methods are the result of more than 2 years of study and research by the Technical Committee headed by H. A. Montgomery, Warren Petroleum Corp., Houston.

All tests have been considerably revised to give them greater accuracy and usability. Apparatus used in vapor pressure, propane residue, and weathering tests have been modified.

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REFINING

Kellogg to Build Two More Fluid Hydroforming Units

NEW YORK. — Cities Service Oil Co. has authorized M. W. Kellogg Co., New York, to proceed with design and engineering of two large-capacity fluid-hydroforming units.

The larger, with an appoximate capacity of 20,000 bbl. daily, will be located at Cities Service's Lake Charles, La., refinery. The second, at East Chicago, Ind., will process about half this volume.

Announcement of the two major plants came within a month after Kellogg's disclosure of the commercial process. The first fluid-hydroforming installation *(The Oil and Gas Journal, June 14, page 53, and July 5, page 115)* is to be placed in operation at Pan-Am Southern Corp.'s Destrahan, La., refinery. It is still on the drawing boards.

The new process is the result of development work by Standard Oil Development Co., Standard Oil Co. (Ind.), and Kellogg.

Richfield Considers Big 2-Year Expansion Program

LOS ANGELES.—Richfield Oil Corp. is contemplating spending $45,000,000 in the next 2 years to expand and modernize its California refinery facilities.

Plans are still in the tentative stage, according to Charles S. Jones, Richfield president, who said that the program if carried through would result in upgrading quality of the firm's products.

Jones said that military demand for products supplied from this area in April was up 78 per cent from April 1950, and civilian demand increased 12.7 per cent during the same period.

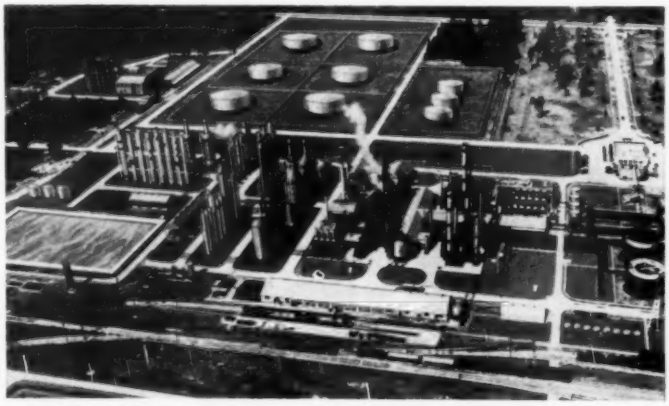
Richfield now sells 80 per cent of its products to civilian domestic buyers, 13 per cent to the military, and exports 7 per cent.

Sinclair Refining Tanker Returns to Coastal Service

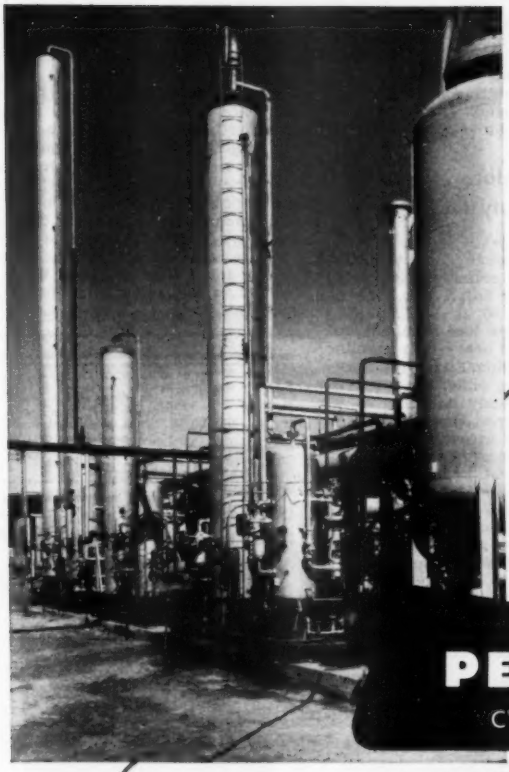
NEW YORK. — Sinclair Refining Co.'s tanker, S. S. Sinclair Superflame, returned to coastal service last week after a 6-week stay in dry dock for conversion to a combination bulk oil and dry-cargo carrier.

The revamped tanker can now carry 14 different grades of lubricating oil in addition to 12 grades of clean products. Its capacity during the remodeling was changed from 94,000 bbl. of products and 518 tons of dry cargo to 25,000 bbl. of lubricating oil, 54,000 bbl. of clean products, and 1,900 tons of dry cargo.

With the addition of the Superflame to the Sinclair feet, the company will be able to ship lubricating oils, refined products, and dry cargo from its refineries at Houston and Corpus Christi, Tex., on the Gulf Coast to terminals on the Gulf and the Atlantic Seaboard. It will discharge products on its northward voyage, and on arrival at Marcus



GOING UP.—Pictured above is an artist's conception of the $24,000,000 expansion program now under way at Continental Oil Co.'s Lake Charles, La., refinery. Most of the new facilities are shown at the left. The additional units will more than triple the plant's present 12,000 bbl. daily capacity. They include: crude distillation, catalytic cracking, catalytic reforming, catalytic polymerization, gas-recovery facilities, and a solvent-extraction unit to separate benzene and toluene. At the extreme upper left of the drawing is Continental Oil Black Co.'s new carbon-black plant.



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Texaco Develops New Series Of Heavy-Duty Engine Oils

NEW YORK.—The Texas Co. has announced the development and marketing of a new series of heavy-duty engine oils, Ursa Oil X Sup. One 10, 20, 30, 40, and 50.

The new series has been adapted for lubrication of heavy-duty gasoline engines and automotive-type diesel engines operating under adverse conditions, the company said.

Texaco developed the series in its research laboratories to meet new and severe lubricating requirements for these types of engines. The requirements are the result of engine-design changes, use of a wide variety of fuels, and use of high-sulfur-content diesel fuels, all of which have resulted in increased engine deposits and greater wear.

The company said the new lubricant delivers satisfactory protection in service employing diesel fuels up to 1 per cent sulfur content.

N.A.C.E. Conducts Drive for New Inhibitor Information

HOUSTON.—The National Association of Corrosion Engineers is now in the midst of a drive to collect new information on inhibitors.

The association said it made no difference whether the information was derived from laboratory research or from field experience. Actual collecting work is being done by Technical Practices Committee 9 on Corrosion Inhibitors.

Contributions ranging in size from one-page observations to complete papers will be received by the committee chairman, Aaron Wachter, Shell Development Co., Emeryville 8, Calif.

Papers received will be discussed critically by the committee and then issued in collected form with discussion as a committee report.

Refining Briefs

Canadian Kellogg Co., Ltd., has begun construction of new refinery equipment at Sarnia, Ont., for Canadian Oil Companies and Canadian Oil Refineries. Equipment includes a new Orthoflow fluid catalytic cracker, a vapor-recovery system, catalytic polymerization plant, and a fractionating tower for splitting butane and propane.

Atlantic Refining Co. has completed construction of its new marine oil terminal at Chelsea Creek, Revere, in the greater Boston area. The terminal was under construction for 2 years. In addition to four storage tanks, loading racks, and other facilities, there are six buildings. They include an office building, an oil-storage-tank building, a warehouse, a garage, a transformer vault, and a foam house with the most modern fire-fighting equipment. At high tide the terminal will accomodate ocean-going tankers. An average discharge rate of 12,000 bbl. per hour enables tankers to unload in about 10 to 12 hours. Work is now under way on installation of two additional tanks.

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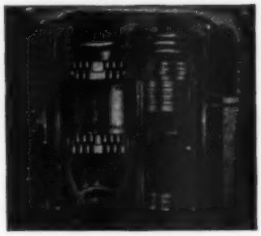

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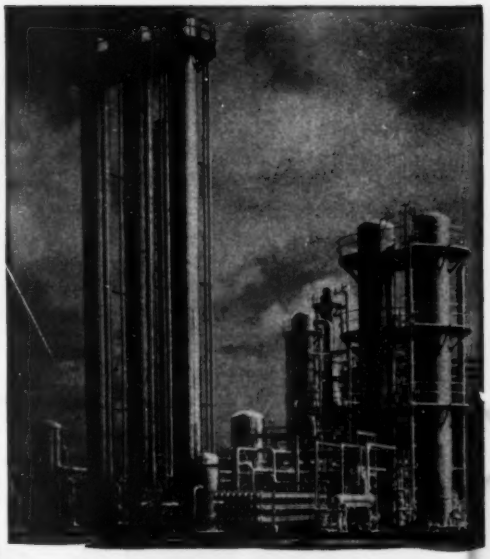

Southwest Gas Producing Co.—Uses

FLORITE

The recently completed gasoline plant of Southwest Gas Producing Company at Dubach, La., gathers wet gas from the surrounding area and employs new highly efficient methods for separating its ethane and propane components. Ninety million cubic feet of natural gas is handled daily, yielding a daily output of 230,000 gallons of liquefied hydrocarbons. The Fish Engineering Corporation of Houston designed and constructed this model plant.

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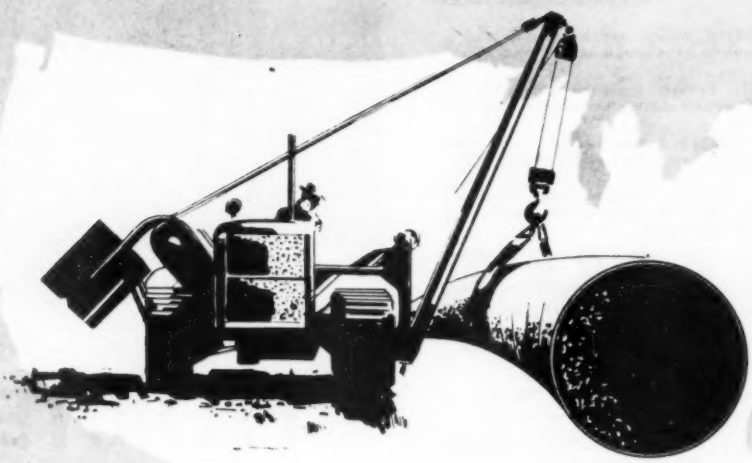

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PIPE LINES

El Paso Nears Completion Of Big San Juan System

EL PASO, Tex.—El Paso Natural Gas Co. is nearing completion of construction of its $44,500,000 pipe-line system from San Juan County, New Mexico, to a point near Topock, Ariz.

Fewer than 32 miles of the 24-in. main line and about 75 miles of gathering lines have not yet been laid. The 450-mile main line will tie in at Topock with a cross-over line from El Paso's southern (Permian basin) lines. The rest of the pipe-line system is complete and ready to be put into operation.

Clearance for construction of the 32-mile segment of main line was obtained by the company recently when the United States Court of Appeals settled a right-of-way dispute by ruling in favor of El Paso over the Department of Interior. *(The Oil and Gas Journal, July 12, page 114).*

The company said that its San Juan River gasoline - treating - compressor plant is more than 70 per cent complete, and the Navajo section near Ganado, Ariz., is about 85 per cent complete.

Applications are pending with the Federal Power Commission on three construction programs which, in total, will increase the authorized deliveries of El Paso by 400,000,000 cu. ft. per day to total 1,500,000,000 cu. ft. daily.

If o.k.'d the applications would: Increase deliveries to West Texas, New Mexico, and Arizona through the Permian basin lines by 100,000,000 cu. ft. per day; increase deliveries to California through the Permian basin lines by 200,000,000 and through the San Juan system by 100,000,000 cu. ft. daily.

It is planned to achieve most of the increased capacity through the addition of more compressor power to already existing lines with a minimum of looping and extension of lines. Nine of the planned compressor stations will use centrifugal compressors powered by gas turbines.

The whole project would call for company expenditures of about $92,000,000.

Inglewood-L. A. Gas Line Sought by California Firms

WASHINGTON.—Southern California Gas Co. and Southern Counties Gas Co. of California, both of Los Angeles, have filed with the Federal Power Commission to build a 23.5-mile natural-gas pipe line from Inglewood, Calif., to Los Angeles.

The proposed 30-in. line would cost an estimated $2,611,875. It would be owned about 75 per cent by Southern California Gas Co. with Southern Counties owning the remainder.

The companies said the line is needed to increase deliverability of gas to the Los Angeles metropolitan area from the La Goleta, Calif., underground storage field. The line also could be used to move gas in the event of emergency interruptions or failure of supplies from portions of their existing systems, the companies said.

Sinclair Eyes Construction Of Four Products Projects

INDEPENDENCE, Kans. — Sinclair Pipe Line Co. is considering the construction of four products pipe lines.

They include an 8-in. line from Sinclair, Wyo., to Salt Lake City; a 10-in. line from Houston to Baton Rouge; either a 16 or 18-in. line from East Chicago, Ind., through South Bend, Ind., and Kalamazoo, Mich., to Detroit; and a 20-in. line from Marcus Hook, Pa., to the Bayonne, N. J., area.

American Republic Gas Line To Silsbee Plant Under Way

SILSBEE, Tex.—Right-of-way has been cleared and construction begun on 28 miles of 6-in. and 14 miles of 3-in. natural-gas pipe line from Village Mills field to American Republic Corp.'s Silsbee natural - gasoline plant about 20 miles north of Beaumont, Tex.

W. L. Golightly, Inc., Houston, holds the contract for construction of the line.

H. C. (Red) Carter is spreadman for the project and will have his field office in Silsbee.

The Silsbee plant has a present capacity of 120,000 gal. per day of liquid products.

P.G. & E.'s 44-Mile Line To King City Gets FPC O.K.

WASHINGTON. — Pacific Gas & Electric Co., San Francisco, can go ahead with construction of its proposed 44-mile natural-gas pipe line in Monterey County, California, under a temporary certificate of authorization granted by the Federal Power Commission last week.

However, the temporary certificate is without prejudice to final commission action in the proceeding.

The line, of 8⅝-in. pipe, will extend from a junction with an existing line south of Salinas, through Chualar, Gonzales, Soledad, and Green-

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field to King City, Calif. Estimated cost of the project is $678,600.

P. G. & E. now distributes propane-air gas in King City and plans to substitute natural gas upon completion of the proposed new line. The company also intends to build distribution systems in Chualar, Gonzales, Soledad, and Greenfield to be served by the line, which will also supply individual customers along its route.

FPC Sets Hearing Date on Southern Natural Expansion

WASHINGTON.—Southern Natural Gas Co.'s plan to increase deliverability of its natural-gas-transmission system from 555 to 670 million cubic feet will be examined by the Federal Power Commission at a public hearing August 6.

The program involves proposed construction of pipe-line facilities in Alabama, Georgia, Mississippi, and Louisiana. It includes construction of three compressor stations with a total of 19,450 hp. and approximately 169 miles of various-size pipe lines. These facilities are estimated to cost $13,641,000.

Hope Natural's Terra Alta Gas Line Approved by FPC

WASHINGTON.—Hope Natural Gas Co. has received Federal Power Commission authorization to build about 33 miles of pipe line in West Virginia to connect Terra Alta gas field with the company's gas-transmission system.

Cost of the project is estimated at $831,000. Hope plans to transport gas from Terra Alta to its system in Fairmont, W. Va., to meet increased requirements in that area. Any surplus gas will go into the company's general system.

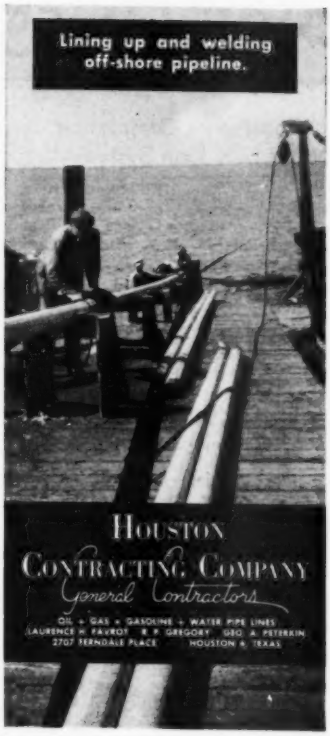
22-Mile Gas Line Sought

WASHINGTON.—Rockland Light & Power Co., Nyack, N. Y., has asked the Federal Power Commission for permission to build 22 miles of transmission line between Orangetown and Tompkins Cove, N. Y., to move gas purchased from Transcontinental Gas Pipe Line Corp. to its eastern division.

The line would cost $735,315 and would have a daily capacity of 11,000,000 cu. ft.

Pipe-Line Brief

Piedmont Natural Gas Co., Inc., within 2 weeks will start pipe laying for the 6-in. lateral from the Transcontinental Gas Pipe Line Corp. system to Winston-Salem, N. C. This is the beginning of building of six lines comprising 58 miles from the Transcontinental line in the area between Greenville, S. C., and Burington, N. C.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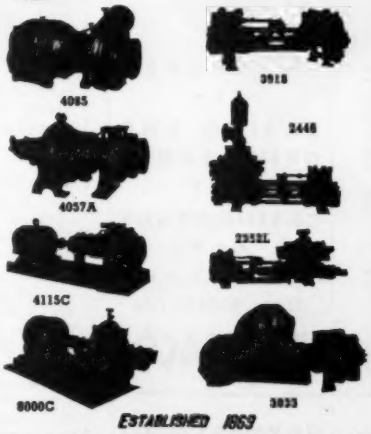

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Among the Drilling Contractors

New Company Acquires Longview Drilling Firm

Capital stock of the Hollandsworth Drilling Co., Longview, Tex., one of the oldest drilling contracting and well-servicing firms in East Texas, has been acquired by Trans-Tex Drilling Co., a new company organized for this purpose by a group of Texas and Wyoming oil men.

The transaction, involving a consideration reported to be approximately $1,000,000, does not include the producing properties of Earl Hollandsworth and Lee Travis, organizers and principal owners of the former company, or of the Hollandsworth Oil Co., whose operations, since early development of East Texas, have been extended over other areas of Texas, as well as Louisiana, Oklahoma, Indiana, Colorado, and Utah.

Management and owners of the new Trans-Tex Drilling Co. include: David C. Bintliff, Houston, long associated with Hollandsworth and Travis in their East Texas operations, president; Clifford W. Trice, formerly with Stanolind Oil & Gas Co. and Hunt Oil Co., executive vice president and general manager; Glenn E. Nielson and M. R. McArthur, president and vice president, respectively, of Husky Oil Co., Cody, Wyo., vice presidents and directors.

David C. Bintliff (right), president, and Clifford W. Trice, executive vice president and general manager of the newly organized Trans-Tex Drilling Co.

Headquarters of the new company will be continued at Longview, where a large tract on Highway 80 opposite the present site of Hollandsworth Drilling Co. has been purchased for the location of a permanent oil building, warehouse, shops, yards and homes for tool pushers.

Hollandsworth Drilling Co. operated five drilling rigs and four well-servicing and workover rigs, all of which, along with all other drilling and auxiliary equipment and assets, have been taken over by the new company.

Gardner Takes Position With Delta Drilling Co.

After a little more than 1½ years spent in the equipment industry as president of International Derrick & Equipment Co., Dallas, Mark Gardner is returning to direct participation in the drilling industry. He has resigned his equipment company presidency to become associated with Delta Drilling Co., Tyler, Tex., as vice president and general manager in charge of that company's drilling operations.

MARK GARDNER

Prior to going with International Derrick & Equipment Co. late in 1949, Gardner was vice president of Loffland Brothers Co., Tulsa, a position he had held since 1946.

Previously, he had been active in drilling and production work since 1933 when he joined the field staff of Phillips Petroleum Co. following his graduation in petroleum engineering from the Colorado School of Mines. He left Phillips for a short time to work as a driller for Loffland Brothers Co. Returning in 1935, he was made drilling superintendent in charge of company tools, and later, in 1945, assistant general superintendent of production. He went from the latter position to the vice presidency of Loffland Brothers Co.

Jennings Drilling Co. is the contractor on a wildcat test which Stanolind Oil & Gas Co. is starting at 1 Watson, in the NW NW NE 26-4s-15w, Tillman County, southwestern Oklahoma.

Montgomery Drilling Co., El Dorado, Ark., has a rig working in the Hico-Knowles pool, Lincoln Parish, Louisiana. Latest operation is for Lion Oil Co. at 1 Barham, C NW NW 30-20n-3w.

Briscoe & Clingman Drilling Co., Oklahoma City, has a new operation under way on the northeast side of the Oklahoma City field, Oklahoma County, Oklahoma. It is another Wil-

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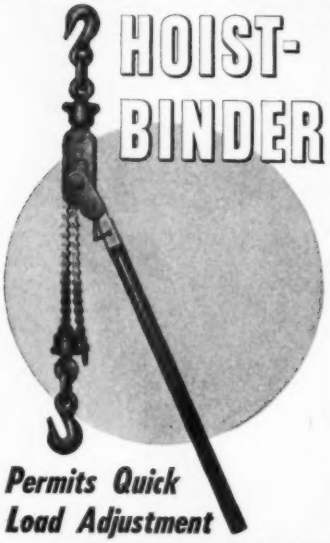

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cox sand well, 1 Block 18, SW SW SE 3-11n-3w, and is being drilled for Powell Briscoe, one of the owners of the contracting company.

Loffland Brothers Co., Tulsa, is setting up a heavy rotary rig on the Croff prospect in McKenzie County, North Dakota, where it will drill a deep test for Amerada Petroleum Corp. Location is in the SW SE 12-149n-96w, on Amerada's Ben Risser lease.

Davenport Drilling Co. has a light rotary rig in the South Comanche Lake area, Stephens County, Oklahoma, where it is starting a projected 2,500-ft. test for William H. Atkinson at 2 Butts, SW NE SE 32-2s-6w.

Penrod Drilling Co., Shreveport, is starting a projected 6,000-ft. test west of the North Shongaloo field, northern Webster Parish, Louisiana, for its associated company, Hunt Oil Co. The test is on Hunt's Lucille Bowin lease in 3-23n-10w.

G. B. Clark, Wichita Falls, Tex., has moved a string of tools to a wildcat location 26 miles east of Colorado Springs, in El Paso County, Colorado, where he has the contract for a projected 7,000-ft. (or Entrada sand) test to be drilled for J. B. Stoddard of Dallas. Location is on state land in the E½ SE NE 20-15s-62w.

Barbour Drilling Co., Tulsa, has a rig working in Kimball County, Nebraska, for Gulf Oil Corp. The operation, the first for Gulf in that state, is 1 Sisson, NW NW NW 18-12n-58w. Location is about 22 miles southwest of Kimball, the county seat. Hole is projected through the Morrison.

Noble Drilling Co. tools are drilling Amerada Petroleum Corp.'s second test in the Tioga area of Williams County, North Dakota. The new operation, 1 Bakken, C SW NW 12-157n-95w, is 11 miles north of Amerada's 1 Clarence Iverson, the state's first oil well, now in process of completion. Hole is projected to 12,000 ft.

ACTIVE ROTARY RIGS*
(United States and Western Canada)

Area—	Week ended 7-16-51	Change week ended 7-9-51	Change week ended 7-17-50
Gulf Coast	574	+11	+ 70
W. Tex.-N. M.	913	— 5	+180
Ark.-N. La.-E. Tex.	158	— 4	+ 5
Oklahoma	313	+25	+ 32
Kansas-S. Nebraska	178	+14	+ 46
Illinois-Eastern	164	+ 8	+ 34
Rocky Mountains	167	+ 6	+ 71
Pacific Coast	145	— 6	+ 5
Total United States	2,610	+49	+443
Western Canada	138	— 3	+ 49
Total	2,748	+46	+492

*Courtesy Hughes Tool Co. Trends in drilling activity in the United States and the West Texas-New Mexico and Oklahoma-Kansas areas are shown on pages 392 and 393.

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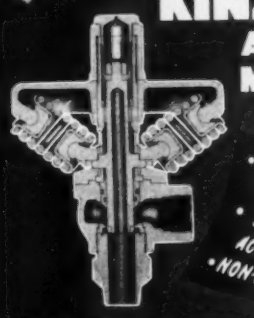

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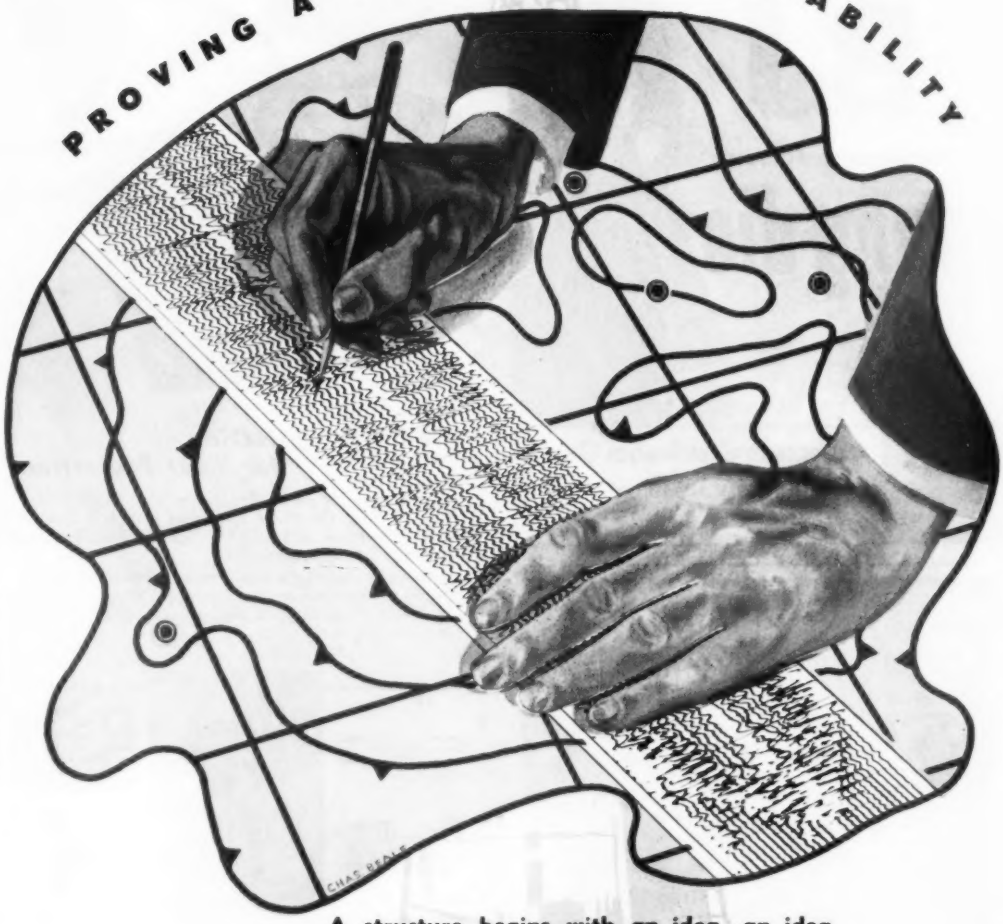

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LEADING THE FIELD OF SEISMIC EXPLORATION

Another Oil Spot for Big Basin

LAST week this page was devoted to the theme that very little is known about the variable Paleozoics and older Mesozoics rocks of eastern Montana, and that several of the drilling wildcats were at depths where anything might happen at anytime. Something did happen.

Shortly after the page went to press came rumors that Shell Oil Co. 1 Northern Pacific Railroad (F on map) had recovered oil. Shell officials would say no more than that their seismograph-located wildcat flowed high-gravity oil at a substantial rate on a 40-minute drill-stem test at 7,183-7,253 ft. *(See news section, this issue.)*

When specific information is lacking on a wildcat as important to an untested area as Shell's is to the Williston-Moose Jaw basin, a great deal of speculation is bound to result. Some geologists say that based on regional studies the tested interval is probably in Mississippian rocks.

The widespread Mississippian sediments in this area can be divided into two parts: Upper Mississippian formations (lowermost Amsden, Heath, Otter, and Kibbey), which are predominantly clastics; and the lower Mississippian formations (Charles and Madison group), which are predominantly nonclastics. All of these formations are believed to have potential reservoir rocks.

Mississippian oil fields are few and far apart in the vast sedimentary unit that sprawls across North Dakota and the eastern portion of Montana and then extends northward to the Arctic Circle by way of the big Devonian fields of Central Alberta. The most important is Turner Valley-Mississippian oil and gas pool (A on map) which was discovered in 1924. Intermittent intensive search in the foothills belt of Southwest Alberta has turned up only two other Mississippian pools. Jumping Pound, gas-distillate pool, immediately to the north of Turner Valley, was discovered in 1944; and Pincher Creek (C on map), a gas-distillate pool with 400 ft. of porous and fractured Mississippian rocks, was discovered in 1948. All three of these fields are fault blocks involving Mississippian-Rundle (Madison) biostrome reservoirs.

Typical of several comparatively small accumulations on the great plains, which are related to the unconformity with the overlying Jurassic or Cretaceous sediments, is the Princess area (B on map) where some Mississippian production has been obtained.

At D is the Cutbank-Kevin Sunburst area where Madison oil was discovered as early as 1926 and is still being developed. The only other Mississippian pool of importance in the mapped area is at Elk Basin-Madison (E on map).

Closest production to Shell's well is at Cedar Creek anticline (G on map) where gas has been produced since 1914 from Upper Cretaceous rocks and small amounts of oil from Paleozoics have been recovered.

The well that brought interest in the Williston basin out in the open was Amerada Petroleum Corp. 1 Iverson (H on map), which flowed oil from 11,630-60 ft. in the Devonian. This famous well has set casing at 11,743 ft. and is now plugged back to 10,540 ft. to check the interval 10,490-10,530 ft. where flowing oil has been developed.

At I is the first producing oil well in Manitoba and in the Williston-Moose Jaw basin. There are now two small pumping wells in this pool which are producing from what is believed to be the eastern wedge edge of the Mississippian series.

Apart from a discovery of oil in a wild area, a significant feature of Shell's well is that production is not at excessive depths as in Amerada's discovery. Depths of 7,000-8,000 ft. are not going to look quite so unattainable financially to many companies as 12,000-ft. holes. This means that the white area on the map is likely to see accelerated interest and activity in the near future.

Philip C. Ingalls

HIGHLIGHTS OF WEEK'S DEVELOPMENTS

CALIFORNIA.—Developments in California fields last week included the opening of a new oil field near Arvin about 1 mile east of the southern end of Mountain View field and a new fault-block discovery in the Edison area, both in San Joaquin Valley; and a new deeper-pay discovery at Seal Beach in the Los Angeles basin.

WEST TEXAS.—Continental Oil Co. 1 Pierson, Yoakum County wildcat, prepared to test oil shows in the Devonian between top at 12,184 ft. and 12,204 ft., total depth. Sunray Oil Corp. 1 Harper, Howard County wildcat northwest of Big Spring, developed 540 ft. of oil on drill-stem test reported as Canyon reef at 8,820-93 ft. Cities Service 1 Adams, northwest of Big Spring, was testing a reef section around 9,191 ft. First test had gas-cut mud.

ROCKY MOUNTAIN AREA.—Shell Oil Co. is running casing for completion of the new Williston Basin, Montana, Richey area discovery. Although complete data has not been released by the company, the well is reported to have flowed on oil drill-stem test at 7,183-7,253 ft. (See News Section, this issue.) General Petroleum Corp. made a discovery in the Manderson area, Big Horn County, Wyoming, with the well flowing 20-30 bbl. of oil per hour from the Embar.

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Texas Gulf Coast

Quintana Finds Deeper Pay North of Long Mott Field

HOUSTON. — Quintana Petroleum Corp. has set casing for completion in a new deeper pay zone about a mile northeast of the Long Mott field, in Calhoun County. The company's 1 W. C. Melbourn, located in I&GN RR Co. Survey A-97, set casing after reaching a total depth of 8,843 ft.

Magnolia Petroleum Co. has set production string in its east outpost test at Provident City field, southeastern Lavaca County. The company's 1 A. L. Paylu is waiting on cement after setting 5½-in. casing at 9,247 ft., with total depth of 9,283 ft. in the deep-pay section of the Wilcox. It is ½-mile southeast of Skelly Oil Co.'s 1 Baber, recent east-extension, gas-condensate well completed at 9,060-9,196 ft.

Sparta Oil Co. and associates have logged gas shows at 9,798 ft. in 1 Lawrence A. Johnson, wildcat 7 miles south of Rock Island in Colorado County, and cuttings indicated 97 per cent sand. Operator will drill ahead into the sand. Present plans call for electrical survey at each 500-ft. interval.

In Chambers County, 6,555 ft. southeast of production in the Oyster Bayou field, Sun Oil Co. will drill 35 Felix Jackson, proposed as an 11,500-ft. exploration 10 miles southwest of Stowell. Drill site is on a 10,-142-acre lease.

Gulf Oil Corp. has derrick up and is preparing to move in for a new 10,700-ft. Wilcox wildcat in Grimes County, 3½ miles south of Yarbrough. Venture is designated 1 William Gardner.

Magnolia Petroleum Co. is preparing to drill a wildcat test to 13,500 ft. in southeastern Lavaca County, South Texas, to explore the basal Wilcox zone. The deep test will be on a lease of 2,681.32 acres in Amanda de la Croix Survey A-112 and will be known as the company's 1 Simpson Heirs. It lies 7 miles southwest of Provident City 6 miles southwest of Provident City field which produces gas-condensate from the Wilcox zone. Skelly Oil Co. has acreage nearby north of the drillsite.

J. G. Gallaher Drilling Co. 1 G. W. Frels, wildcat in Bee County about 4 miles southeast of Beeville, has set production string and is preparing to perforate for production test. Total depth is 4,022 ft., with 5¼-in. casing set to about 4,000 ft. Several sands have indicated showings in this well. Well lies in John Ryan Survey A-63, 2½ miles southeast of Yougeen field.

Sunray Oil Corp. has plugged back and set whipstock to sidetrack and recore its 2 H. C. Dillworth, southwest outpost test at "Northeast Goibel" area of Live Oak County, South Texas. The well missed the oil column in the Luling sand, getting only gas in both the Slick sand, topped at 7,044 ft., and Luling zone, topped at 7,191 ft. It was drilled and cored to a total depth of 7,530 ft. then plugged back. Last drill-stem test reported, at 7,273-80 ft. in a lower stringer of the Luling sand, recovered salt water.

Rowan & Hope of San Antonio are coring ahead below 7,574 ft. after logging and testing gas-condensate pay in the Wilcox zone in H. C. Gansow semiwildcat in the "Henze" area of DeWitt County. Well lies 5½ miles south of Yorktown and 2,900 ft. southeast of Rowan & Hope's 1 Henze gas-discovery well in Jose Santos Survey A-420.

TEXAS GULF COAST (DISTRICTS 2 AND 3) SUCCESSFUL WILDCATS

Austin County: Oil Drilling, Inc. 1 D. L. Hart, et al, gas, David T. Davis, A-160, TD 10,252 ft., 1,580,000 cu. ft. daily, 11/64-in. choke, open flow 3,100,000 cu. ft. daily, 52.2° gravity, GOR 50,000:1.

Orange County: Ohio Oil Co. 1 Luther Moore Lumber Co., oil, C. L. Higginbotham A-414, TD 9,038 ft., perf. 7,983-8,716 ft., IP: 284 bbl. per day, 12/64-in. choke, 40.8° gravity.

TEXAS GULF COAST (DISTRICTS 2 AND 3) WILDCAT FAILURES

Brazoria County: Edwin L. Cox 1 Mary Zellmer Rott, J. E. Phelps A-117, dry, TD 9,534 ft.

N. B. Hunt 1 A. D. Suderman Unit 1, A. H. & B. Lot 7 A-6, dry, TD 11,778 ft.

Calhoun County: John W. Mecon 1 Howard Kenyon, Jr., et al, E. Yates 1 (Green Lake) Sur., dry, TD 8,945 ft.

Chambers County: Humble Oil & Refining Co. 1-B B. W. Dutten, et al, Benjamin Winfree A-28, dry, TD 8,330 ft.

Fort Bend County: Carnes W. Weaver 1 Rudolph Gubbels, John M. Wade A-343, dry, TD 8,500 ft.

Goliad County: Dallas Husky, et al, 1 Ella & Harry May, Sampson McTernal Sur. A-195, dry, TD 3,376 ft.

Jefferson County: Houston Oil Co. et al 1 J. M. Bebert, E. D. Chinneth A-104, dry, TD 8,388 ft.

Sam Maceo Oil Operators 1 J. E. French, Thomas Spears A-50, dry, TD 7,515 ft.

Liberty County: Claud B. Hamil and Wm. A. Smith 1 Harvey Mecom, Edward Tanner League, dry, TD 8,002 ft.

Refugio County: Holly Development Co. 1 J. A. Hynes, John Alene Sur. A-46, dry, TD 7,210 ft.

Wharton County: Mac Drilling Co. 1 Joe Tobola, I&GN RR Sec. 15 A-236, dry, TD 3,998 ft.

Mississippi

Continental Well Completed As Virlillia Field Opener

JACKSON.—In Madison County, the Virlillia field-discovery well, Continental Oil Co. 1 John R. Cameron, SE SW Section 36-10n-1e, has been officially completed flowing 209 bbl. of 38.9°-gravity oil plus 78 bbl. of salt water per day through 12/64-in. choke with flowing pressure of 650 psi.

Only a trace af gas is being produced with the oil and water. Production is from perforations at 10,559-63 ft. opposite Hosston (Lower Cretaceous) sand and gravel. The well was drilled to a total depth of 14,258 ft. in Smackover. On a test of open hole below casing which was set at 13,783 ft., the well flowed noninflammable sour gas which was 93.4 per cent carbon dioxide. After this test, the operators plugged back to test shows in the Hosston.

In southwestern Franklin County, the South White Apple field discovery well, Dave Gammill-Lyle Cashion Co. 1 D. F. Anderson, Section 3-5n-1e, after being shut in while treater and tanks were installed, was opened on ¼-in. choke on casing. Flowing pressure at that time was 320 psi. At last report the flowing pressure had dropped to 185 psi. and the well had been shut in again. It is reported that operators are of the opinion that, since the pressure has dropped, they will now be able to run a string of tubing and proceed with a normal completion. While the well was open, it did not flow enough oil to make a gage.

In Adams County, approximately 4.7 miles north of production in Kingston field, a possible new Wilcox discovery is preparing to test at the R. J. Bartkett-Kemp Drilling Co. B-1 Minter, Section 52-5n-1w. This wildcat was drilled to a depth of 7,015 ft. in Wilcox. Log and sidewall samples indicated 5 ft. of oil sand from 6,697-6,703 ft. Drill-stem test using dual packers at 6,692 and 6,700 ft. recovered 3,530 ft. of oil and gas, and 90 ft. of salt water. Maximum top pressure at the end of the 15-minute test was 20 psi. Bottom-hole pressure was 975 psi. flowing and 2,800 psi. shut in for 10 minutes. Casing has been run and perforated above and below the oil sand and block squeezed. Production test has been scheduled.

MISSISSIPPI SUCCESSFUL WILDCAT

Madison County: Continental Oil Co. 1 John R. Cameron, Sec. 36-10n-1e, TD 14,258 ft., IP: flowed 209 bbl. oil plus 78 bbl. of salt water in 24 hours, 12/64-in. choke, TP 650 psi., 38.9° gravity.

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The early electrical logs were plotted by hand, as pictured in this illustration of recording in California in 1932. Present day logs are recorded photographically on film and four or more curves can be recorded simultaneously on the same log.

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Permian Basin

Martin County Well Flows 584 Bbl. From Devonian

MIDLAND.—In northwest Martin County, Pan American Production Co. and Forest Oil Co. 1 Breedlove completed as a Siluro-Devonian discovery, flowing 584 bbl. of 41°-gravity oil in 6 hours through ¾-in. choke. Daily potential was at the rate of 2,340 bbl.

The big producer topped the Devonian at 11,956 ft., minus 9,061 ft., then drilled ahead to the Ellenburger which was dry. Completion perforations were from 12,078-12,118 ft. Drill-stem tests indicated some 90 ft. of pay zone.

In southeast Martin County, Ryan Consolidated Petroleum Corp. 1 Peters had treated the Spraberry with Hydrafrac. The well was swabbed twice and made a flow of some 56 bbl. of oil in 16 hours through 9/32-in. choke. The well was then shut in to move the rig.

Southwest of Stanton, Union Oil Co. 1 Snyder & Arnett was completed as a pumper making 35.8 bbl. of oil a day plus considerable water. The wildcat had pay from open hole at 7,160-7,245 ft.

Deep Rock Oil Corp. 1 Mrs. Nettie McWhorter, north of Stanton, was swabbing with total depth at 7,850 ft., in the Spraberry. Recovery had not been reported.

A Pennsylvanian discovery, or 3-mile extention to the Shafter Lake area, has been completed in Andrews County at Cities Service Oil Co. and others 1-B Reed. On potential test the well flowed 483 bbl. of 38°-gravity oil in 24 hours through ½-in. choke from perforations at 9,129-34 ft. The well was drilled to 10,999 ft. after topping the Devonian at 10,820 ft., on elevation of 3,116 ft.

Sohio Petroleum Co. completed its 1-B Hunt in 6-37-4S-T&P as a long northwest extension to the Driver Spraberry field of southeast Midland County. On potential test the well flowed 147 bbl. of oil a day through 42/64-in. choke from pay at 7,228-7,320 ft. Location is 1¼ miles north of Sohio's 1-A Hutt, recent 1-mile west extension to the field.

The Mound Lake area of northeastern Terry County received another exploratory test at Texas Gulf Producing Co. 1 Dan Auld. The well is to be a Pennsylvanian reef test contracted to 9,500 ft. Location was farmed out from Seaboard Oil Co., Sohio, and Golston Oil Corp. and is 1 mile northeast of Seaboard 1 Hinson.

New Spraberry production west of the Pembrook field in Upton County has been assured at Sohio 1 Hill, 2-K-D&SE Survey. First test after treatment from 7,045-7,100 ft. produced 96 bbl. of oil in 4 hours, and 224 bbl. in 12 hours through 24/64-in. choke. There was no water.

Tom Green County had a new Strawn discovery 6 miles northeast of San Angelo at Louis E. Scherck 1 Willie Johnson. On 24-hour flowing test the well gaged 165.6 bbl. of 47°-gravity oil through ¼-in. choke from perforations at 4,712-38 ft. Location is 1½ miles north of Shell Oil Co. 1 Johnson, small Strawn discovery completed on the pump.

Phillips Petroleum Co. 2 L. S. McDowell, southwest of shallow production on the south end of the Howard-Glasscock field, Glasscock County, had prospects of oil in the Wolfcamp.

Drill-stem test from 6,790-6,871 ft. recovered fresh water and 120 ft. of 33°-gravity oil in 2½ hours. Top of the Wolfcamp, at 6,480 ft. on elevation of 2,548 ft., was reported 215 ft. high to the 1 McDowell, also drilled by Phillips and which was dry in the Ellenburger at 10,906 ft.

York & Harper 1 Wright, northeast Yoakum County wildcat, was to plug back from 6,084 ft. to 6,010 ft. for production tests. Drill-stem tests in the Glorietta from 5,931-

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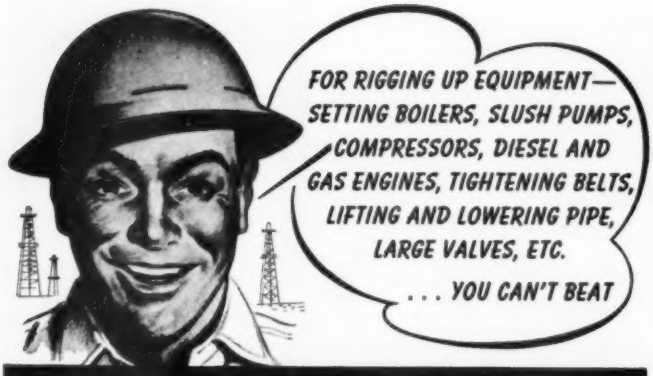
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6,030 ft. produced oil by heads. Water was encountered below 6,030 ft.

WEST TEXAS (DISTRICTS 8 AND 7-C) SUCCESSFUL WILDCAT

Scurry County: R. Olsen Oil Co. 1 J. W. Templeton, 52-3-H&TC, TD 7,435 ft., elev. 2,295 ft., Ellenburger 7,300 ft., IP flowed 219 bbl. 42°-gravity oil a day, ¼-in. choke, TP 125 psi., GOR 750 cu. ft.

WEST TEXAS (DISTRICTS 8 AND 7-C) WILDCAT FAILURES

Andrews County: M. O. Rife, Jr. 1 M. M. Fisher, 5-A36-PSL, dry, TD 4,750 ft.

Concho County: Holland Oil Co. et al 1 Scott Hartgrove, Sec. 2, T. F. Benge Sur., dry, TD 3,796 ft., elev. 1,650 ft., Caddo 3,042 ft., Ellenburger 3,472 ft.

Cottle County: Deep Rock Oil Corp. 1 Portwood Ranch, Sec. 57, A. Forsythe Sur., dry, TD 7,714 ft., elev. 1,699 ft., Pennsylvanian 5,297 ft., Mississippian 7,015 ft., Ellenburger 7,653 ft.

Dawson County: Plymouth Oil Co. 1 Dell Barron, 9-35-5N-T&P, dry, TD 9,175 ft., elev. 2,971 ft., Spraberry 7,152 ft., Pennsylvanian reef 9,164 ft.

Garza County: Continental Oil Co. 1 Ralph Welch, 2-4-K. Aycock Sur., dry, TD 8,350 ft., elev. 2,399 ft., Strawn 7,545 ft., Ellenburger 8,310 ft.

Runnels County: Gallaher & Silver 1 W. R. Edwards, N. Travis Sur. 533, dry, TD 4,275 ft.

Houston Oil Well Service Co. 1 Oscar Brown, Sec. 7, SA&MG Sur., dry, TD 4,385 ft., Serratt 2,403 ft., Palo Pinto 3,370 ft.

G. W. Strake 1 Harris Davenport, J. Ximinez Sur. 265, dry, TD 4,603 ft., elev. 1,819 ft., Palo Pinto 3,319 ft., Goens 3,790 ft., Capps 3,690 ft.

G. Withersoon and J. Fox 1 N. Smith, Blk. 528, P. Brown Sur., dry, TD 4,050 ft., Serratt 2,450 ft.

Tom Green County: J. R. Medlock 1 Lulu J. Turner, Sec. 233-A, F. Volmar Sur., dry, TD 1,100 ft.

Upton County: Cities Service Oil Co. 1 Noelke, 4-A-MK&T, dry, TD 6,815 ft., elev. 2,501 ft., Simpson 6,170 ft., Ellenburger 6,765 ft.

Great Western 1 M. L. Smiley, 15-B-CCSD&RGNG, dry, TD 7,846 ft., elev. 2,714 ft., Spraberry 6,924 ft.

Yoakum County: Chapman & McFarlin 1 E. S. Turner, 2-D-J. H. Gibson Sur., dry, TD 6,315 ft., elev. 3,584 ft., San Andres 4,710 ft.

SOUTHEASTERN NEW MEXICO

HOBBS.—Skelly Oil Co. 1-J Mexico-State, Lea County wildcat just west of the Dollarhide area of Andrews County, Texas, recovered 20 ft. of clean oil, 1,400 ft. of water blanket, 1,080 ft. of gas-cut mud and considerable sulfur water on a 3-hour test of the Fusselman from 8,775-8,890 ft. Clean oil had been recovered previously from 8,545-8,629 and 8,629-93 ft. Drilling continued below 8,898 ft.

Magnolia Petroleum Co. 2-B Betenbaugh, Ellenburger test on the west side of the Bough Pennsylvanian field, was drilling lime and chert at 12,091 ft., with no shows reported.

Southwest of the Bough field, Magnolia 1 Four Lakes Unit was drilling below 12,444 ft. Drill-stem test at 11,920-43 ft. recovered water blanket and mud.

The Texas Co. 1 State, 2-11s-37e, was drilling below 11,101 ft. Drill-stem test at 10,364-10,445 ft. recovered 580 ft. of drilling mud, gas-cut and having a strong oil odor.

SOUTHEAST NEW MEXICO SUCCESSFUL WILDCAT

Lea County: Continental Oil Co. 1-B Warren-Unit, 27-20s-38e, TD 9,392 ft., PB 6,844 ft., elev. 3,552 ft., perf. Drinkard 6,790-6,816 ft., IP flowed 117 bbl. 38°-gravity oil a day, 14/64-in. choke, GOR 103 cu. ft., TP 200 psi.

SOUTHEAST NEW MEXICO WILDCAT FAILURES

Eddy County: Robert E. McKee 1 McKee-State, 2-20s-29e, dry, TD 1,559 ft., elev. 3,328 ft., Yates 1,337 ft.

Estelle H. Yates 2 Lane-Federal, 19-19s-30e, dry, TD 1,899 ft., Yates 1,575 ft.
Lea County: Oil Associates, Inc. 1 Edwards, 22-18s-32e, dry, TD 6,200 ft., elev. 3,757 ft., Queen 3,862 ft.
Wilson Oil Co. 1 Sunray-State, 5-21s-4e, dry, TD 3,850 ft., elev. 3,717 ft., Yates 3,602 ft.

TEXAS PANHANDLE (DISTRICT 10) WILDCAT FAILURE

Oldham County: Superior Oil Co. 1-A. Howard, 85-K6-GB&CNG, 3 mi. E, 6 mi. S Adrian, dry, TD 8,640 ft., elev. 4,143 ft., pre-Cambrian 8,560 ft. (?).

Appalachian-Ohio

Activity Increases In West Virginia

PITTSBURGH.—In Union district, Preston County, West Virginia, Eberly & Snee located 1 Clarence Jones, elevation 1,830 ft. on the Kingwood Quadrangle 1.05 miles south of Lat. 39°, 25′, and 0.15 mile west of Long. 79°, 35′. In Baileysville district, Wyoming County, United Producing Co., Inc. 1-1757 Pierce Short et al tested 2,908,000 cu. ft. of gas, total depth 3,460 ft.; in Oceana district, Hope Natural Gas Co. 9635 Loup Creek Colliery Co. got 1,107,000 cu. ft. of gas, total depth 3,959 ft. Forty new locations were reported: Sheridan and Sherman districts, Calhoun County; Falls district, Fayette County; Center district, Gilmer County, Ravenswood district, Jackson County; Elk district, Kanawha County; Court House district, Lewis County; Harts Creek district, Lincoln County; Chapmansville district, Logan County; Sandhill and Webster districts, Marshall County; Harvey district, Mingo County; Grant district, Monongalia County; Big Creek district, McDowell County; Jefferson district, Nicholas County; Union district, Preston County; Union district, Putnam County; Grant district, Ritchie County; Walton district, Roane County; Centerville district, Tyler County; Buckhannon district, Upshur County; Union district, Wayne County; Harris district, Wood County; Oceana district, Wyoming County.

In Garrett County, Maryland, Eberly & Snee completed a good gas well (see wildcat paragraphs). New locations in the same area were made by Oil Ventures, Inc. 1 George Beckman, and New York State Natural Gas Corp. 1-N-240 John K. Shaw. In the vicinity of the Blocher well drilled some time ago in the same county, Borden has located 1 Will Robeson.

In Cameron County, Grove Township, Pennsylvania, New York State Natural Gas Co. completed its 1 State of Pennsylvania Tract 1, semiexploratory well, as a dry hole at 6,626 ft. The Oriskany was found at 6,608 ft.

In Clinton County, Leidy Township, Leidy Prospecting Co. brought in 1 Schoonover for 1,300,000 cu. ft. of gas at final depth of 5,629 ft. Rock pressure was 1,200 psi. in 12 hours. Oriskany was topped at 5,611 ft. G. L. Cabot, Inc. 1 Wykoff failed at 6,793 ft., finding no oil, gas, or water in the Oriskany. A semiexploratory venture in East Keating Township got only a show of gas after shooting and acidizing the Oriskany. The well, New York State Natural Gas's 1 State of Pennsylvania Tract 2, went to 6,407 ft., and logged the Tully at 5,243 ft., Onondaga at 6,360 ft. and Oriskany at 6,374 ft.

MARYLAND SUCCESSFUL WILDCAT

Garrett County, Mountain Lake Park section: Eberly & Snee 1 fee, elev. 2,447 ft., 2,200,000 cu. ft. gas, chert 3,360 ft., Oriskany 3,487 ft., gas 3,487-91 ft., TD 3,600 ft.

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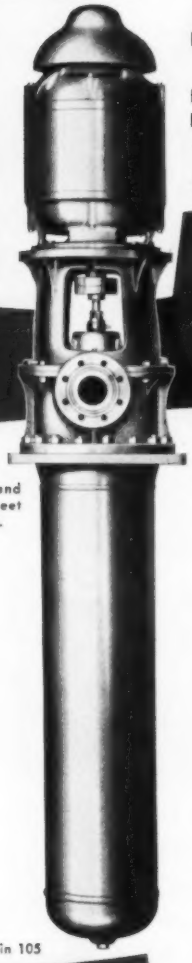

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CP-2

Coshocton County, topped the Clinton at 3,261 ft., and was drilled through the sand with good showings of oil. In 24 hours after shot, the well made 193 bbl., making it the third largest well in the field.

Another good Newburg well was brought in by Ohio Fuel in Knox Township, Holmes County, in 2 M. L. Kline, Section 30. Sand was found at 2,443-75 ft., and gas gaged 1,250,000 cu. ft. natural.

J. C. Steiner et al drilled in a small well on a ¾-mile stepout in Lake Township, Stark County, and in the same township have started drilling on a wildcat. The 1 Levi Troyer, Section 15, logged the Clinton at 4,468-4,539 ft. with 260,000 cu. ft. natural. When shut in after shooting with 80 qt., the well gaged 310,000 cu. ft. with 1,320 psi. The wildcat is on L. G. Brett in Section 20.

The Oxford Oil 1 K. Ridenbaugh, Section 16, Killbuck Township, Holmes County, made 10 bbl. natural and 30 bbl. after shot. Clinton was found at 3,390-3,452 ft.

California

New Oil Field Opened East of Mountain View

LOS ANGELES.—Developments in California fields last week included the opening of a new oil field near Arvin and a new fault-block discovery in the Edison area, both in San Joaquin Valley; and a new deeper-pay discovery at Seal Beach in the Los Angeles-basin area.

The Arvin discovery was The Texas Co. 1 George, about 1 mile east of the southern end of the Mountain View field, NE NW Section 23-31s-29e. Drilled to 6,516 ft. with 7-in. casing set at 6,377 ft., the wildcat was completed flowing at the rate of 24 bbl. hourly through an ⅛-in. bean. Water cut was about 25 per cent and the crude was 32° gravity. Flow was through 151 ft. of perforated 5½-in. liner landed at 6,514 ft.

About 4 miles to the northwest, in the area between the Edison and Mountain View fields where new pool discoveries have been made quite frequently in recent months, a new Chanac sand fault-block pool was opened. Discovery well was the California Exploration Co. and Macmillian Petroleum Co. 27-1 "Well" in SW SW Section 27-30s-28e. It was completed flowing and pumping about 100 bbl. daily of 22.5°-gravity crude from the Chanac sand, which was topped at 4,030 ft. Drilled to 4,750 ft., hole had been plugged back to 4,320 ft. and 7-in. casing landed at 4,310 ft.

The pool opener is located about ½ mile southeast of the same operators 28-2 Porter which was completed about 3 months ago. It found the top of the Chanac at 3,500 ft. and was completed flowing 150 bbl. daily through perforations at 3,742-3,800 ft.

At Seal Beach the deep test being drilled by Continental Oil Co. 62 Bixby in the central portion of the field, found a new deeper pay at 7,723-7,894 ft. On a 2-hour drill-stem test of that section some 600 ft. of water cushion and 4,800 ft. of crude were recovered. A prior test at 7,555-7,603 ft. had yielded 780 ft. of gas-cut mud and 380 ft. of gas and oil-cut mud. Continental was reaming hole preparatory to running casing.

Among the new wildcats staked was the Harry H. Magee, Oper., 1 Powell in Section 20-25s-24e, about 2½ miles southeast of the Trico gas field, Kern County. It will seek gas production in the Atwell zone at about 3,500 ft.

After setting surface pipe at 500 ft., L. M. Lockhart was preparing to drill ahead at his wildcat in the Panoche Creek area of Fresno County. The new test, 1-36 Souza in Section 36-14s-12e, is about ¾ mile west of a 10,357-ft. wildcat drilled by the same operator earlier this year. An attempt was made to test showings in the Cretaceous but they were inconclusive and activity was suspended. Objective of the 1 Souza

will be the San Joaquin sand with drilling scheduled to go about 12,000 ft.

Northwest of the Thornton gas field in Sacramento Valley, The Texas Co. abandoned its efforts to open a new gas area with its 1 Vorden. Located in Section 15-15n-4e, the wildcat was drilled to 4,775 ft. Tests in the Capay sand, topped at 4,226 ft., found water as did later tests at 3,797 ft.

CALIFORNIA SUCCESSFUL WILDCAT

Kings County: New oil field discovery 1½ miles southeast of Pyramid Hills field—Norris Oil Co. 115-28 "Well," NW SW 28-24s-18e, pumped 60 bbl. 14°-gravity crude and 40 bbl. water daily from perforations at 852-92 ft., top upper Temblor oil sand 856 ft., TD 893 ft., elev. 647 ft.

CALIFORNIA UNSUCCESSFUL WILDCATS

Fresno County, Gill Ranch area: Shell Oil Co. 57-19 Ponte, 19-13s-17e, dry, TD 4,800 ft., elev. 213 ft.

Kern County, Edison area: San Joaquin Drilling Co. 4 Di Giorgio, 8-13s-30e, dry, TD 1,152 ft., elev. 535 ft.

Mount Poso area: The Texas Co. 2 T.S. Glide Two, 33-27s-28e, dry, TD 2,066 ft., elev. 868 ft.

Monterey County, San Ardo area: Helm Co. 1 Hans R. Sumpf & Robert Sumpf Adrian - Orradre, 31-21s-11e, dry, TD 2,078 ft., elev. 875 ft.

Sacramento County, Vorden area: The Texas Co. 1 Vorden, 15-5n-4e, Capay sand 4,226 ft., dry, TD 4,775 ft., elev. 10 ft.

San Luis Obispo County, Branch Mountain-Carrizo Plains area: The Texas Co. 4 Grayson-Owen, 32-30s-18e, dry, TD 3,689 ft., elev. 2,029 ft.

Santa Cruz County, Watsonville area: The Texas Co. 1 M. Light, 14-11s-1e, dry, TD 3,694 ft., elev. 415 ft.

Ventura County, Cuyama Valley area: Arthur C. Fisher 54 Curyea, 27-9n-23w, basement 930 ft., dry, TD 974 ft., elev. 4,050 ft.

North Central Texas

Throckmorton County Well Tests New Caddo Production

WICHITA FALLS.—A new Caddo discovery was in prospect for Throckmorton County at Warren Petroleum Corp. 1 G. Williams, 6½ miles southeast of Woodson. A drill-stem test in top of the section from 3,556-70 ft., open 1 hour and 20 minutes, had gas in 15 minutes and recovered 17 bbl. of oil plus some oil-cut mud. Second test between 3,570-90 ft. produced flowing oil in 64 minutes and recovered 5½ bbl. of oil in the pipe. It was drilling ahead.

Warren 1 Annie Johnston, wildcat 5 miles east of Woodson, completed from both the Caddo and the Mississippian. Caddo perforations at 3,690-3,732 ft. produced 81.3 bbl. of 40°-gravity oil in 5 hours through 18/64-in. choke, for a calculated 390-bbl. a day potential. Mississippian potential of 684 bbl. of oil was based on a 114-bbl. flow in 4 hours, through open outlet, from pay at 4,510-22 ft.

Sinclair Oil & Gas Co. will drill its 1 S. F. Murrell in northeast Cooke County as an Ellenburger exploration. The proposed test lies 2¾ miles southwest of Cosefield in the Alexander Horton Survey. Contract depth was 6,300 ft.

Skelly Oil Co. has made location for 1 G. S. Stubbs in the D. G. Burnett Survey, Knox County, for a 6,000-ft. exploration. Location is about 1½ miles southwest of the North Knox City Palo Pinto field.

In Taylor County, Southern Minerals Corp. 1 J. E. Graham, Gardner sand prospect northwest of Ovalo, was reported yielding 5-6 bbl. of oil an hour on the swab. Tests were on open hole between 4,439-48 ft.

F. W. Cooper 1 Reeves, Montague County

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semiwildcat southwest of OWR conglomerate field, found oil-cut mud and salt water on a drill-stem test in conglomerate from 5,536-68 ft. It was drilling ahead.

Deep Rock Oil Corp. 1 L. P. Moore, east offset to the company's Strawn sand discovery in Clay County, east of Newport, was delayed by a fishing job at 6,634 ft., total depth.

NORTH CENTRAL TEXAS (DISTRICTS 9 AND 7-B) SUCCESSFUL WILDCATS

Archer County: Frank Wood 1 Frank McAnally, M. W. Matthews Sur., 8 mi. N Megargel, TD 5,390 ft., elev. 1,321 ft., Mississippian 5,319 ft., pay 5,387 ft., IP flowed 216 bbl. 42°-gravity oil a day, ½-in. choke, TP 600 psi.

Baylor County: British American Oil Producing Co. 21 J. H. Turbeville, Sec. 197, T&NO Sur., 13 mi. E Seymour, TD 5,486 ft., elev. 1,235 ft., Caddo 5,120 ft., perforated 5,115-50 ft., IP pumped 50 bbl. 40°-gravity oil a day.

Anderson-Prichard et al 1-C Cowan, Blk. 196, T&NO Sur., 7 mi. NE Seymour, TD 2,578 ft., pay 2,568-75 ft., IP flowed 94 bbl. 38°-gravity oil a day, 15/64-in. choke, TP 100 psi., GOR 300 cu. ft.

Coleman County: Ed Watts 1 Era Strozier, Sec. 271, A. Gobel Sur., 9 mi. NE Coleman, TD 1,917 ft., perforated 1,894-1,910 ft., IP flowed 125 bbl. 42°-gravity oil a day, 16/64-in. choke, TP 180 psi., GOR 400 cu. ft.

Yeatman Drilling Co. 1 Frank Hudson, Blk. 49, GH&H Sur., 3½ mi. NE Novice, TD 3,769 ft., pay 3,253-59 ft., IP flowed 11 bbl. 45°-gravity oil a day, 7/64-in. choke, TP 460 psi., GOR 15,300 cu. ft.

Denton County: Lee Hicks 1 Bessie Forrester, J. B. Barroux Sur., 5 mi. NW Bolivar, TD 1,721 ft., pay 1,718 ft., IP pumped 30 bbl. 40°-gravity oil a day.

Palo Pinto County: R. W. Fair et al 1 M. H. Grainger, 41-2-T&P, TD 1,236 ft., pay 1,229 ft., IP pumped 20 bbl. 40°-gravity oil a day.

Stephens County: A. B. Edwards 1 J. A. Crowley, 33-6-T&P, TD 2,215 ft., sand 2,212 ft., IP 6,900,000 cu. ft. gas daily.

Taylor County: Humble Oil & Refining Co. 1 J. R. Black, 289-64-H&TC, TD 5,477 ft., pay 4,902-08 ft., IP flowed 147 bbl. 40°-gravity oil a day, TP 160 psi., GOR 1,491 cu. ft.

Throckmorton County: Woodson Oil Co. 1 Buchanan, Sec. 928, TE&L Sur., 5 mi. NW Woodson, TD 4,800 ft., Caddo pay 4,049 ft., IP flowed 456 bbl. 41°-gravity oil a day, 28/64-in. choke, TP 975 psi., GOR 985 cu. ft.

Young County: Reno Oil Co. et al 1 Pemeta, Blk. 1,467, TE&L Sur., 2 mi. N Jean, TD 5,114 ft., Mississippian 5,020 ft., perforated 5,025-38 ft., IP flowed 124 bbl. 40°-gravity oil a day, ½-in. choke, TP 750 psi., GOR 500 cu. ft.

Warren Oil Corp. 1 Marvia Dent, TE&L Sur., 2,387, 12 mi. SW Newcastle, TD 3,773 ft., elev. 1,214 ft., Caddo 3,762 ft., IP flowed 111 bbl. 31°-gravity oil a day, 14/64-in. choke, TP 100 psi., GOR 565 cu. ft.

NORTH CENTRAL TEXAS (DISTRICTS 9 AND 7-B) WILDCAT FAILURES

Archer County: R. H. Alexander 1 J. A. Ayers, M. Fanning Sur., dry, TD 740 ft.

J. M. Hawley 2 M. H. Taylor, Blk. 14, Taylor & ATNCL Sur., dry, TD 1,605 ft.

Rycade Oil Corp. 1 W. B. Ray, Blk. 3, Harris Subd., Club Ranch, dry, TD 5,284 ft., Caddo 4,879 ft., Mississippian 5,266 ft.

Cooke County: Empire Drilling Co. 1 J. W. Robertson, C. DeMorse Sur., dry, TD 1,868 ft.

T. P. Frost 1 Ramsey, B. F. Curtis Sur., dry, TD 1,730 ft.

Nelson Drilling Co. 1 H. W. Stark, J. M. Dickson Sur., dry, TD 2,505 ft.

Denton County: Taylor Drilling Co. 1 L. O. McLaughlin, A. H. Lynde Sur., dry, TD 1,612 ft.

Haskell County: Arkansas Fuel Oil Co. 2 C. J. Kleiner Estate, J. M. Cass Sur., dry, TD 2,853 ft.

West Central Drilling Co. 1 C. T. Jones, 32-46-H&TC, dry, TD 5,581 ft.

Hood County: Sunray Oil Corp. 1 John R. Black, Lower Thomas Robinson Sur.,

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dry, TD 5,448 ft., Marble Falls 4,575 ft., Ellenburger 5,220 ft.

Jones County: Humble Oil & Refining Co. 1 Mrs. R D. Jones, Sec. 76, BBB&C Sur., dry, TD 5,075 ft.

B. C. McMordie and C. E. Groover 1 H. M. Lawson Sur. 5, dry, TD 2,074 ft.

Oxford Drilling Co. 1 Lula Grimes, Sec. 4, OAL Sur., dry, TD 2,873 ft.

Knox County: Skelly Oil Co. 2 Gertrude L. Howell, 65-13-H&TC, dry, TD 6,085 ft., elev. 1,469 ft., conglomerate 5,740 ft., Mississippian 5,806 ft.

Palo Pinto County: L. B. Barkley 1 A. J. Hoover, Blk. 11, Richard Starr Sur., dry, TD 2,335 ft.

Stonewall County: General Crude Oil Co. 1 Pauline Ybarra, 174-1-H&TC, dry, TD 6,427 ft., Ellenburger 6,383 ft.

Taylor County: Miller Bros. Drilling Co. 1 T. C. Richardson, Sec. 15, BAL Sur., dry, TD 2,202 ft.

Young County: Neeld & Hood Drilling Co. 1 E. R. Prideaux, CTRR Sur. 1, dry, TD 3,654 ft.

Southwest Texas

Zapata County Well Shows Oil East of Escobas Field

CORPUS CHRISTI. — A Zapata County wildcat has made an oil show on test 2 miles east of the old Escobas field and 3 miles south of Escobas. Earl A. Thompson is preparing to run another test on his 2 M. Garza wildcat, which was drilled to a total depth of 1,675 ft. Gas sand was recovered when coring from 1,661-75 ft., and a drill-stem test on that interval gave a working pressure at the surface of 700 psi. through ¼-in. chokes. The well lies on a 1,400-acre lease in Survey 284.

The Edwards lime yielded sulfur water on a drill-stem test at Amerada Petroleum Corp.'s 1 Florence Schuelke wildcat 5½ miles south-southwest of Paige in southeastern Bastrop County, South Texas. Tool was open 2 hours on test at 6,592-97 ft., with ¼-in. chokes top and bottom, and using a 90-ft. water cushion. A blow reached the surface immediately and was followed by gas in 25 minutes. Maximum working pressure was 112 psi. in 24 minutes.

Goldston Oil Corp. of Houston apparently has hit new production in eastern Frio County about 2 miles southeast of Big Foot field. The firm's Anna Weitting is now coring the third "Olmos" sand after testing oil in the first Olmos sand and getting shows also in the second Olmos sand of the Navarro zone. The drill-stem test run in the first Olmos sand is reported to have recovered 175 ft. of oil and mud (25 per cent mud) and the well is reported to have had 45 ft. of good oil sand in this zone. Well lies in the southeast corner of the north half of Dan Price Survey 6, A-1026, 18 miles northeast of Pearsall.

Stanolind Oil & Gas Co. 1 State Tract 421, wildcat 5 miles south of Ingleside in Corpus Christi Bay, flowed 72 bbl. of oil and 1,238,000 cu. ft. of gas in 10¾ hours on a 3/16-in. choke. The well produced from perforations at 7,280-86 ft., and operators are drilling ahead after squeezing these perforations. The well was bottomed at 8,854 ft., and 7-in. casing is cemented to 8,836 ft.

Eastern States Petroleum Co., Inc., has completed its southeast extension to gas-condensate production at West Bishop field in southern Nueces County. It is waiting on potential test from perforations at 7,211-14 ft. with 12 shots and 7,231-46 ft. with 60 shots, where well flowed gas-condensate with no gage. Total depth is 7,805 ft. with 5½-in. casing set to 7,338 ft. for completion.

A shallow sand strike has been developed by Lundell Brothers of Alice at their 8 E. C. Lundell, wildcat west of the North

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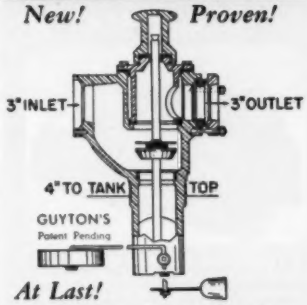

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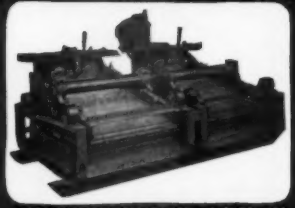

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BOX 1470 TULSA, OKLA.

Government Wells field in northwestern Duval County. Fifteen-minute drill-stem test at 1,858-63 ft. recovered 360 ft. of pipeline oil. No water showed on the test. At last report the venture was waiting on potential test.

SOUTHWEST TEXAS (DISTRICTS 1 AND 4) SUCCESSFUL WILDCATS

Duval County: Magnolia Petroleum Co. 2 Sinclair Heirs, gas, AB&M Sur. 499, A-45, TD 3,264 ft., TP 760 psi., 28,500,000 cu. ft. per day open flow.

Hidalgo County: The Texas Co. 1 Yturria Land & Livestock, gas condensate, Antonio Miguel Cano A-81, TD 6,715 ft., perf. 4,386-92 ft., IP: 78,000,000 cu. ft. per day, 69° gravity.

Nueces County: Panhandle Producing & Refining Co. 1 Knolle Farms, gas, Bluntzer Partition, TD 5,197 ft., perf. 5,162-72 ft., IP: 120,000,000 cu. ft. per day.

Sunray Oil Corp. 1 State Tract 351, oil, State Tract 351, Red Fish Bay, TD 8,714 ft., perf 7,960-72 ft., IP: 174 bbl. per day, 9/64-in. choke, TP 1,200 psi., 42° gravity.

San Patricio County: Lee Brothers Oil Co. 1 A. A. Miller, oil, E. J. McGloin Sur., TD 4,654 ft., perf. 3,696-3,704 ft., IP: 84.78 bbl. on 10/64-in. choke, TP 183 psi., 36° gravity.

Wilson County: M. L. Wise et al (Martin, Shelly & Thomas) 1 Kate Higging, oil discovery, Rafael Salinas Sur. 343, A-228, TD 5,632 ft. open hole 5,590-5,632 ft., IP 328 bbl. per day through 12/64-in. choke.

SOUTHWEST TEXAS (DISTRICTS 1 AND 4) WILDCAT FAILURES

Bastrop County: C. L. Hurst et al and Greer & McClelland 1 E. G. Templeton, dry, TD 2,218 ft.

Duval County: Daubert-Achning & Edwin L. Cox 1 Yates Ranch, dry, William Gray Sur. 7, A-212, TD 2,350 ft.

The Texas Co. A-1 DCRC NCT-1, dry, Quirino Gonzales Sur., 588, A-1726, TD 2,210 ft.

Jim Hogg County: Sun Oil Co. 42 Jones, dry, Auga Nueva De Abajo Grant, TD 4,399 ft.

Jim Wells County: H. H. Howell 2 Alice Dunn, dry, Lot 61, J. B. Dibrell Subd. of Wade Ranch, Casa Blanca Grant, TD 5,159 ft.

H. H. Howell 1 Katie Dunn, dry, Lot 50, J. B. Dibrell Subd. of Wade Ranch, Casa Blanca Grant, TD 5,532 ft.

Liebman-Gibson Drilling Co. 1 R. L. Childs, abandoned, "La Vaca" Jose Maria Garcia, A-166.

Kenedy County: Humble Oil & Refining Co. B-27 J. G. Kenedy, Jr., dry, El Paistle Grant, TD 3,055 ft.

Kinney County: Fish Production Corp. 1 Roy Henderson, dry, T&GN Ry. Co. Sur. Block 11, A-675, TD 2,592 ft.

McMullen County: V. C. Schimmell 1 Clifton Wheeler, dry, C. C. Shumway Subd., Sec. 5, William McGill Sur. 54, A-308, TD 1,588 ft.

Nueces County: The Chicago Corp. 1 Reidman Est., dry, Sec. 158 of F. B. Bishop Subd. of Weil Ranch, TD 7,519 ft.

Seaboard Oil Co. of Delaware and Southern Minerals G-1 C. Driscoll, dry, C. H. Paul Subd. of Driscoll Ranch, TD 6,762 ft.

San Patricio County: Seaboard Oil Co. of Delaware 1 R. C. Roos, et al, dry, Sec. 35, George H. Paul Subd. of Coleman-Fulton Pasture, TD 9,020 ft.

Starr County: Chicago Corp. B-1 Bessie H. Cooke, dry, "B" El Javali Grant, TD 2,310 ft.

Dee Davenport 1 Ola Bowers Simpson, dry, Sur. 887, A-1013, TD 5,503 ft.

McCarrick Oil Co. 1 Hinojosa Estate, dry, Porc. 111, A-98, TD 2,298 ft.

McCarrick Oil Co. 2 Hinojosa Estate, dry, Porc. 110, TD 2,243 ft.

McCarrick Oil Co. 3 Hinojosa Estate, dry, Porc. 110, TD 2,154 ft.

Webb County: O. W. Killam 1 Leopoldo Lopez, dry, Sur. 139, TD 3,665 ft.

Wilson County: George Parker and Charles L. McCune 1 H. G. Click, dry, David Murphree Sur. 1, A-207, TD 2,930 ft.

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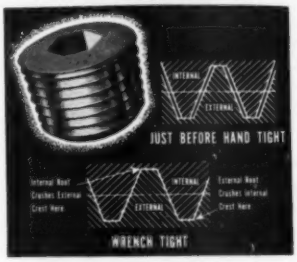

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Third Pool Indicated For Hodgeman County

DISCOVERY of another new pool, the third, in Hodgeman County, in the far western part of the state, is indicated by oil showings encountered by Kingwood Oil Co. at its 1 Folkerts, SE SE SE 21-21-23. Located 8½ miles northeast of Jetmore and about 7 miles northeast of the Jetmore pool, opened by Shell Oil Co. last year as the county's first production, filled 1,595 ft. with oil in a 45-minute drill-stem test at 4,302-22 ft. in Marmaton lime. Since the test, hole has been deepened to 4,535 ft. in the Mississippian, topped at 4,529 ft. and casing run to 4,531 ft. for completion. The Jetmore pool, as well as the Purdyville pool, 9 miles to the southwest, opened earlier this year as the second pool for the county, produces from the Mississippian.

In the Purdyville pool, M. B. Armer is starting tests in his 2 Schraeder, C E½ SE NW 3-24-24, a location southeast of the discovery well. When plug was drilled out, oil rose 3,700 ft. in the hole. Total depth is 4,679 ft. with the Mississippian pay zone topped at 4,657 ft. Hole is open below 4,664 ft.

The McKinney gas-distillate field in southeastern Meade County, in the southwestern part of the state, has an indicated 1½-mile southward extension and a possible second producing zone where Skelly Oil Co. is testing its 1-B Theis, SW SW NE 11-34-26. From casing perforations at 5,757-71 ft. in Morrow sand (Pennsylvanian), logged at 5,758-69 ft. and acidized with 1,500 gal., the well flowed at an estimated rate of 4,735,000 cu. ft. of gas daily. Additional acid will be applied for further testing. Hole was drilled to 6,123 ft., topping Mississippian, the producing zone of the three wells which have been completed in the field, at 5,785 ft. Bottom of the casing is at 5,938 ft. The field was opened last year.

A new Layton sand pool is being opened in southeastern Sumner County, further east on the southern tier of counties. The discovery well, Herndon Drilling Co. and associates 1 Gurley, NE SW NE 6-35s-1e, swabbed 8 to 10 bbl. of oil per hour from that sand, topped at 3,026 ft. and drilled to 3,071 ft. Location is 4 miles southwest of the Portland pool, nearest production. Pay zone of the latter pool, opened last year, is the Simpson sand.

El Dorado Refining Co. 1 O'Connor, NE NE SE 8-24-12, a wildcat located 16 miles northwest of nearest production in the Stafford pool, southern Stafford County, flowed gas at an estimated rate of 200,000 cu. ft. per day and recovered some free oil in a 45-minute drill-stem test in the upper part of the Viola lime, topped at 3,850 ft. (—1,964 ft.). Test took in an interval at 3,851-67 ft. Hole has been deepened to 3,914 ft., where 5-in. casing has been cemented for completion.

KANSAS SUCCESSFUL WILDCATS

Phillips County: Rine 1 Slinker, SW SW SE 25-4s-20w, pumped 118 bbl. oil from Lansing at 3,215-23 ft., TD 3,500 ft., Heebner 3,076 ft., Dodge 3,105 ft., Lansing-Kansas City 3,119 ft., cherty Sooy 3,437 ft., Arbuckle 3,456 ft.

Seward County: White Eagle 1 Bozarth, NW NW SE 12-35s-33w, 286,000 cu. ft. gas from Marmaton at 5,230-60 ft., TD 6,466 ft., Herrington 2,585 ft., Lansing-Kansas City 4,526 ft., Atoka 5,635 ft., Morrow 5,847 ft.

Stafford County: Petroleum, Inc. 1 Newcomb, SW SW SW 5-21s-13w, pumped 560 bbl. oil from Lansing at 3,471-83 ft., TD 3,652 ft., anhydrite 791 ft., Heebner 3,189 ft., lime 3,307 ft., sandy Sooy 3,575 ft., Simpson shale 3,590 ft., Arbuckle 3,601 ft., opens East Dell.

Petroleum, Inc. 1 Bayer, SE SE SE 16-21s-14w, pumped 183 bbl. oil from Lansing at 3,558-66 ft., TD 3,762 ft., anhy-

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drite 856 ft., Heebner 3,266 ft., lime 3,382 ft., basal Kansas City 3,626 ft., Sooy 3,651 ft., Viola 3,656 ft., Arbuckle 3,742 ft., opens Bayer.

Armer 1 McBride, SE NE SE 14-22s-14w, pumped 884 bbl. oil from Arbuckle at 3,780-84 ft., TD; anhydrite 780 ft., Heebner 3,298 ft., lime 3,424 ft., Lansing-Kansas City 3,438 ft., Viola 3,707 ft., Simpson 3,732 ft., opens North Oscar.

KANSAS WILDCAT FAILURES

Barton County: Aylward 1 Drews, NE SE NW 6-18s-11w, dry, TD 3,415 ft.

Butler County: Beardmore 1 Wolf, NE SE NW 31-26s-3e, dry, TD 3,280 ft.

Aladdin 1 Oliver, NE SW SW 19-2ns-4e, dry, TD 3,218 ft.

Ainsworth et al 1 Reschke, SW SW SE 9-28s-3e, dry, TD 3,155 ft.

Cowley County: Carter 1 Winchell, SW SW NE 6-35s-5e, dry, TD 3,213 ft.

Tatlock 1 Mathews, SW NE NE 14-30s-7e, dry, TD 2,965 ft.

Ellis County: Lion 1 Lee, CWL SW SE 34-12s-20w, dry, TD 3,901 ft.

Graham County: Gore 1 Nelson, NE NE NE 28-6s-25w, dry, TD 4,350 ft.

Kingman County: Virginia 1 Hamman, NW NW SW 2-27s-5w, dry, TD 4,275 ft.

Lyon County: Lance Hill et al 2 Redecker, NE NE NE 17-20s-12e, dry, TD 1,275 ft.

Norton County: Great Lakes Carbon 1 Muir, NW NW SW 12-3s-23w, dry, TD 3,722 ft.

B&R 1 Stone, SE SE SE 19-4s-21w, dry, TD 3,700 ft.

Phillips County: National Associated 1 Heth, SW SW NE 10-1s-18w, dry, TD 3,443 ft.

Rice County: Shade & Berry 1 Neel, C SW NW 24-19s-6w, dry, TD 3,405 ft.

Rooks County: B&R 1 Brown, CNL NE NE 9-8s-20w, dry, TD 3,460 ft.

Deep Rock 1 Burrton, SW SW SW 16-8s-20w, dry, TD 3,590 ft.

Peel-Hardman-Appleman 1 Berland, SE SE SE 17-10s-19w, dry, TD 3,590 ft.

Russell County: The Texas Co. 1 Russell, SE NW SE 7-20s-16w, dry, TD 3,918 ft.

Shawnee County: Lynn 1 Nelson, SW SW NE 13-12s-16e, dry, TD 2,518 ft.

Stafford County: Westgate-Greenland 1 Russell, SE SE NW 6-22s-14w, dry, TD 3,895 ft.

Vernon 1 Dale, SW SW SE 4-23s-12w, dry, TD 3,772 ft.

Sumner County: Francis 1 Hayter, NE NE NE 2-31s-4w, dry, TD 4,665 ft.

Harwood et al 1 Ward, NE SE SE 21-33s-2w, dry, TD 4,465 ft.

Trego County: Nye 1 Kingsley, NE NE SE 33-12s-22w, dry, TD 4,112 ft.

Brunson 1 Luea, SE SE SE 12-14s-21w, dry, TD 3,980 ft.

Rine 1 Madden, NW NW NE 17-14s-21w, dry, TD 4,351 ft.

Davis-Child et al 1 Jesse, NE NE NE 5-15s-24w, dry, TD 4,243 ft.

South Louisiana

William H. Hunt Wildcat Producing From 8,323-30 Ft.

NEW ORLEANS.—The William H. Hunt 1 Powell Lumber Co., drilled in Section 36-6s-12w, is producing 42.9°-gravity oil from perforations at from 8,323-30 ft.

Total depth is 8,394 ft. No further information was released on the well.

Operators have perforated State Lease 1605-Blind Bay, off Plaquemines, at a second interval. The Texas Co. wildcat, which showed salt water and a gas odor at 13,288-95 ft., is now being readied for testing at 12,898-12,938 ft.

The Texas Co. also is perforating a new section at its Lake Borgne try in Orleans. The section is from 7,610-22 ft.

Humble has abandoned its Lake Maurepas well, the State Lease 1865. It was dry at 10,000 ft. This is the second setback for the field within a month.

Gaylord Container Corp. 1-C still awaits testing truck for a test at 9,004-10 ft. The Washington Parish wildcat drilled by Hum-

ble has shown condensate and gas-cut mud, small oil shows, sand with gas and salt water, and mud at varied intervals.

H. P. Gonsoulin No. 1, a potential deepest world producer being drilled by Shell in Weeks Island field, is still being worked over. Operators are attempting to test.

SOUTH LOUISIANA WILDCAT FAILURES

Lafourche Parish: Roeser & Pendleton 1, Southdown Sugars, Inc., 72-14s-16e, dry, TD 12,379 ft.

Rapids Parish: Kemp Drilling Co. and D. D. Feldman Oil & Gas Co. 1 Maria Brousek, 22-4n-2e, dry, TD 8,042 ft.

St. Bernard Parish: Estate of William Helis 1 State Lease 1828, 21-16s-17e, dry, TD 10,493 ft.

Oklahoma

New Wilcox Sand Pool Found in Logan County

A PROMISING oil discovery appears to have been made in eastern Logan County where a wildcat drilled by J. G. and W. F. Catlett, Zephyr Petroleum Co. and Oklahoma Natural Gas Co., joint operators, made a substantial oil and gas flow during a drill-stem test of saturation found in second Wilcox sand. The prospective new producer is 1 Giddins, located in athe SE NE NW 21-17n-1e, 3 miles east of Langston. It is about 2½ miles north of the Northwest Iconium pool and 3 miles southwest of the East Coyle pool, nearest production.

Sand was topped at 5,070 ft. and cored to 5,082 ft., where the drill-stem test, taking in the interval below 5,069 ft., was made. Gas flow, starting within 6 minutes after the tester was opened, was at an estimated rate of 3,000,000 cu. ft. per day. Oil was at the top within 18 minutes and flowed at an estimated rate of more than 25 bbl. per hour. Tester was open a total of 45 minutes.

Stephens Petroleum Co. has opened additional pay in its 1 Haas, NW SE NE 9-2s-3w, Humphreys (Springer) sand discovery well north of Fox in Carter County. The well first was tested only from the upper Humphreys zone, opposite which casing was perforated at 6,408-18 ft., and from which it flowed 291½ bbl. of oil in 16 hours through 29/64-in. choke. Since then, operators have perforated casing at 6,434-51 ft. opposite the lower Humphreys zone. From both zones, the well flowed 48½ bbl. of oil in the first 6 hours. Latest reported gage was 229.5 bbl. in 24 hours through 22/64-in. choke. The location is about a mile west of production at the southern portion of the Sholem Alechem pool and about 1½ miles north of the Fox-Graham pool.

A new Booch sand pool is being opened in Seminole County about 1¾ miles southeast of production of the Seminole pool, between that pool and the Sanchez pool, a mile further southeast, where Flynn Oil Co. 1 Best, NW NE NE 32-9n-7e, swabbed and flowed 10 bbl. of oil per hour in early tests through casing. Booch sand was logged at 3,388 ft. and penetrated to 3,419 ft., the present total depth. Hole is open below 3,392 ft. The well was started as a Cromwell sand test.

Promising oil showings also have been found in Booch sand in a wildcat located 4 miles northwest of Atwood, in Hughes County. The wildcat, Van Grisso Oil Co. and Republic Natural Gas Co. 1 Bilby, NE NE NW 17-6n-9e, cut the first Booch sand at 2,823 ft. A 60-minute drill-stem test taking in an interval at 2,833-43 ft. got a good gas blow and recovered some free oil along with 30 ft. of heavily oil and gas-cut mud. Second Booch sand, topped at 2,993 ft. and penetrated to 3,070 ft., also showed oil and gas. Two drill-stem tests were attempted but results were inconclusive due to failure to get good packer shutoffs. At latest

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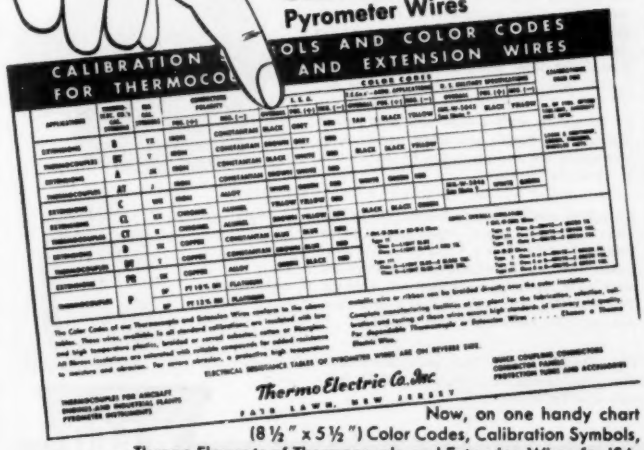

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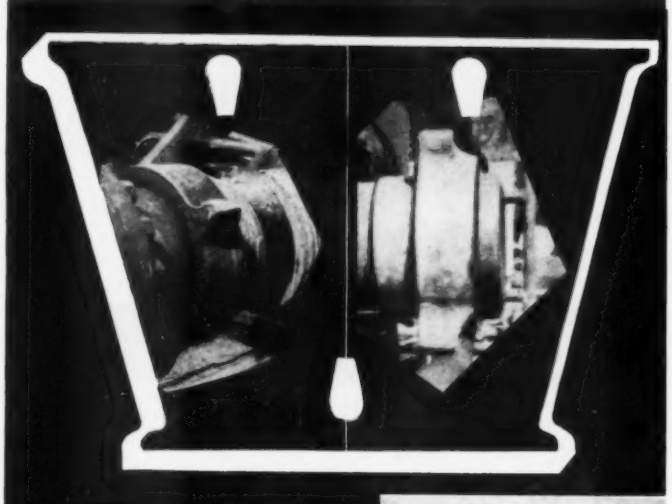

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report, operators were drilling ahead in Gilcrease sand.

Flynn Oil Co. 1 Terry, SW SW SE 14-12n-6e, which is opening a new Hunton lime pool 4 miles northeast of Prague, in southeastern Lincoln County, is being put on the pump for completion after a swabbing test in which it made 25 bbl. of oil in 9 hours. Production is from open hole at 4,390-4,410 ft. Pay zone was treated with 2,000 gal. of acid.

OKLAHOMA SUCCESSFUL WILDCATS

McClain County: Carter 2 N. R. Johnson, C SW SE 30-8n-2w, flowed 166 bbl. 35.5°-gravity oil from Oil Creek at 8,967-9,010 ft., TD 9,012 ft., Hunton 7,500 ft., Chimney Hill 7,655 ft., Sylvan 7,700 ft., Viola 7,795 ft., dense 8,100 ft., reopens West Noble.

Pawnee County: Ashland Oil & Refining 1 Eye Bear, NW NW NW 35-21n-5e, flowed 21 bbl. oil from Bartlesville at 3219-27½ ft., TD; Hogshooter 1,990 ft., Checkerboard 2,350 ft., Oswego 2,800 ft., Prue 3,000 ft.

OKLAHOMA WILDCAT FAILURES

Beckham County: Gradan Petroleum Corp. 1 Toon, NW NW NW 11-8n-25w, dry, TD 2,333 ft.

Garfield County: McCaughey et al 1 Hayes, NW SW SE 20-21n-4w, dry, TD 4,905 ft.

Lincoln County: Josaline 1 State, SW SW SE 36-16n-4e, dry, TD 4,095 ft.

Noble County: Dirickson-Lewis Drilling 2 Ebersole, NE NE NW 11-21n-1w, dry, TD 3,660 ft.

Summit Drilling 2 Rogan, SE SW NW 29-21n-1w, dry, TD 5,101 ft., geological test in Perry.

Sinclair 1 Bufford, SE SW NW 1-24n-1w, dry, TD 5,174 ft., geological test in Tonkawa.

Osage County: O. H. Parker 1 Osage, NW SE NE 29-29n-6e, dry, TD 2,908 ft.

Pawnee County: Foundation Oil and A. A. Cameron 1 School Land "B," SE SW NE 16-21n-6e, dry, TD 2,627 ft.

Pottawatomie County: Brown 1 Beaver, NW NW SE 19-9n-2e, dry, TD 6,303 ft.

Barrett et al 1 Fisher, NW NW SE 18-10n-3e, dry, TD 5,175 ft.

Stephens County: Carlock 1 Branch, NW NW SE 31-1s-7w, dry, TD 5,081 ft.

Canadian Fields

Peace River Area Gets Dual-Zone Gas Strike

CALGARY.—The Peace River region of northwest Alberta has a new important natural-gas discovery in two zones at a wildcat in the Hamelin Creek area drilled by the team of Hudson's Bay Oil & Gas Co. and Union Oil Co. of California. The well is located on a 7½-section farmout secured from the team of Texaco Exploration and McColl-Frontenac Oil Co. The venture is Hudson's Bay-Union-Texaco 1, in LSD 16, 29-80-6w6, in virgin territory about 30 miles southwest of the Shell-British American Whitelaw gas field and 40 miles due east of the Pacific Group Pouce Coupe gas area. Designated as a Mississippian test, the Hamelin Creek wildcat is now drilling below 3,340 ft., following a series of drill-stem tests above that level.

The first discovery was recorded in the Peace River sand, from 1,770-90 ft., with drill-stem test yielding a gas flow rate of 2,214,000 cu. ft. daily and pipe recovery of 20 ft. of mud. Salt water is at base of this sand, for a test of interval 1,788-1,800 ft. gave a gas flow rate of 403,000 cu. ft. daily, a blow of muddy water to surface in 15 minutes, and pipe recovery of 270 ft. of salt water.

The second and most important gas discovery came in the basal Gething sand section, where over 60 ft. of pay sand indicated a gas potential of perhaps 25,000,000 to 30,000,000 cu. ft. A test of interval 3,271-3,305 ft. recovered gas at the rate of 6,500,000 cu. ft. daily. The interval at 3,300-10 ft. gave gas at a 6,700,000-cu. ft. rate, with interval

3,293-3,320 ft. showing 7,000,000 cu. ft., and interval 3,320-30 ft. having 7,434,000 cu. ft. daily. The base of the zone had a show of oil and salt water. A test of interval 3,330-40 ft. gave gas at only 50,000 cu. ft. daily, with pipe recovery in 90 minutes of 2,310 ft. of fluid, including 30 ft. of muddy oil, 150 ft. of 25°-gravity oil, and 2,130 ft. of salt water.

An oil show has been obtained at a wildcat well being drilled in the Bashaw area of Central Alberta by American Leduc Petroleums, Ltd. The well, American Leduc Bashaw 1, LSD 16, 31-41-22w4, on a drill-stem test of interval 5,662-82 ft. recorded a pipe recovery of 40 ft. of oil-cut gassified mud. The crew is continuing to rathole ahead in D2 zone of Devonian.

Decalta Oils, Ltd., of Calgary, has announced location for a new exploratory well in the St. Paul area of northeast Alberta, to be drilled under agreement with Trans-Vaal Oil Co. Decalta-Trans-Vaal-St. Paul 1, in LSD 4, 21-59-8w4, is about 9 miles northeast of the town of St. Paul and 18 miles southwest of the Tor-American Bonnyville 1, indicated oil discovery, which is currently running production tests to evaluate shows of oil in the Colony sand. The well, being drilled as a test of the Lower Cretaceous to an approximate depth of 1,500 ft., is expected to start within about 2 weeks.

Imperial Oil, Ltd., has staked location for a wildcat in the Dinant area, about 3½ miles north of the Anglo-Home-C&E-Camrose Viking sand oil wells, and close to 5½ miles east of the Armena wells, which showed small quantities of high gravity crude oil. The new venture, Imperial-Dinant 1, in LSD 16, 17-48-20w4, is about 15 miles southeast of Joseph Lake oil field, source of first Viking oil production in Alberta. The well, slated as a test of Devonian possibilities down to the D3 equivalent, is expected to start within the next 2 weeks.

CANADIAN SUCCESSFUL WILDCAT

Wagner-Dillabough-Matlo-Ad Astra 1, LSD 12, 36-54-25w4, TD 3,685 ft., 675 bbl. oil daily.

CANADIAN WILDCAT FAILURES

Delhi Socony Rosemary 1, LSD 5, 22-21-16w4, TD 3,912 ft.

Socony Oliver 1, LSD 5, 7-54-23w4, TD 5,036 ft.

Tower Long Island Camrose 12-22, LSD 12, 22-47-20w4, TD 3,236 ft.

EASTERN CANADA

CHATHAM, Ont.—In Elgin County, Richfield Oil & Gas 4, John D. Graham farm, Lot 6, Aldborough Township, finished at 400 ft. with around 150 bbl. a day flush, has settled to 25 bbls.

In the same general area, A. G. Bailey Co., Ltd., Calgary, has leased acreage, and is still in its first shallow test, with Clarence Stork supervising drilling and survey operations. The company is also planning a deep test in the same area.

In Norfolk County, Roy Mandley & Sons, Dunnville, drilling just west of Port Rowan for Dominion Natural Gas Co., has completed a fair gasser at 1,380 ft. Production will be marketed by Dominion.

Petrol Oil & Gas Co. of Toronto will drill six wells on the Six Nations Indian Reserve near Brantford in Brant County to supplement gas production already secured from some 40 wells.

In the Bruce Peninsula, Bruce Oil & Gas Co., Detroit, has let contract to G. H. Rawlings to drill several Trenton lime tests near the center of the peninsula, some 25 miles south of Tobermory. Trenton production is expected around 1,415 ft.

In Kent County, Action Oil & Gas Co. has completed a dry hole on the Virgil McGuigan farm in Harwich Township near Cedar Springs. The well, testing a potential gas horizon around 1,550 ft., was carried to 1,750 ft.

In Essex County, the Harry B. Smith syndicate of Windsor is moving a rig to drill a Trenton test on the Oliver Mowat Wigle farm in Gosfield Township near Kingsville. Drilling will be carried to between 2,800 and 3,000 ft.

Eastern Texas

Warren to Drill in Long Inactive Gregg County Area

DALLAS.—New wildcat locations were uppermost in East Texas field news this week. Gregg County, long inactive, received a 7,500-ft. test by Warren Petroleum Corp., 1 Henderson Unit in the David Hill Survey 4 miles northeast of Longview.

In Morris County, Morris Coats staked location for 1 B. E. Reese in the TCRR Survey, a 5,500-ft. Paluxy wildcat. Coats 1 Reese, wildcat 4 miles northwest of Naples, was dry last week at 7,110 ft. It had top of the Travis Peak at 6,962 ft.

In Lamar County, G. M. Jordan and others staked location for Rosa Coursey, a 5,400-ft. wildcat southeast of Reno in the B. J. Drummond Survey.

E. V. McCright and W. S. Guthrie have started operation at 1 R. L. Griggs, Navarro County wildcat 3 miles northeast of Kernes. At last report it was drilling ahead at 1,695 ft.

In Hunt County, J. C. Harper 1 V. T. Banks, wildcat northeast of Greenville, topped the sub-Clarksville at 2,454 ft. and was coring ahead at 2,462 ft. Core recovery from 2,450-59 ft. was tight sand with light gas shows.

In the new North McMillan field, Grayson County, L. O. McMillan 2 Thorn was drilling ahead at 3,440 ft. It is an Oil Creek sand test scheduled to 8,600 ft.

Northwest of Sherman, Standard Oil Co. of Texas 1 S. F. McKeon, A. Humes Survey, was drilling below 5,344 ft. Drill-stem test in unidentified formation at 5,131-41 ft. recovered 750 ft. of free oil.

EAST TEXAS (DISTRICTS 5 AND 6) SUCCESSFUL WILDCAT

Wood County: Cliff W. Trice 1 Four States Oil Co., H. Payne Sur., 5 mi. NW Haw-

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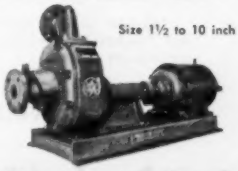

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EAST TEXAS (DISTRICTS 5 AND 6) WILDCAT FAILURES

Cherokee County: Coats Drilling Co. 1 A. Anderson, J. L. Trimble Sur., dry, TD 5,506 ft., Buda 5,460 ft.

Falls County: J. H. Gilmore 1 J. V. Hamilton, J. O. Rice Sur., dry, TD 1,000 ft. H & W Drilling Co. 1 D. E. Currie, C. C. Lupton Sur., dry, TD 1,650 ft., Buda 1,070 ft.

Hunt County: E. C. Huggins 1 M. N. Satterwhite, M. D. Bullion Sur., dry, TD 3,174 ft.

Titus County: B. L. Hoover 1 F. P. Webb, S. McGaughey Sur., dry, TD 5,396 ft., Woodbine 3,630 ft., Georgetown 4,355 ft., Paluxy 5,317 ft.

Wood County: Bracken Oil Co. 1 L. A. Bryan, J. Hamby Sur., dry, TD 5,800 ft. Vernon Whiteley Drilling Co. 1 D. M. Davis, B. West Sur., dry, TD 4,797 ft., Woodbine 4,400 ft.

Rocky Mountain

Shell Running Casing To Complete Strike

DENVER.—Shell Oil Co. is running casing for completion of the important Williston basin discovery in Dawson County, Montana. The well is 1 Northern Pacific Railroad, SE NW NW 19-23n-50e, in the Richey area, northwest of the long Cedar Creek anticline in eastern Montana. Complete data on the test has not been announced by Shell, although the company confirmed that the well flowed on a 40-minute test of the zone at 7,183-7,253 ft. Unofficial reports from the area indicate that production is from the basal Madison (Mississippian) and estimates of potential vary from 1,000-4,000 bbl. of oil daily. The discovery is of extreme importance to the entire Rocky Mountain region and immediately following the test brokers from all oil regions moved again to the Williston basin for additional leasing. More than 200 brokers were reported working in the two-state area of eastern Montana and western North Dakota. The lease activity throughout this basin intensified following discovery of oil in the Devonian-Silurian (?) at the Amerada Oil Corp. Beaver Lodge wildcat, 135 miles northeast of the new discovery in Williams County, North Dakota, some months ago. Leasing extended westward through the basin and north through the Canadian portion of the basin. There is an estimated 40,000,000 acres leased in the region at the present time.

South of the Richey area wildcat three new wells are starting along the Cedar Creek anticline. Shell has spudded another wildcat on the Pine Unit, Wibaux County, at 1 Unit, SW SW SE 30-12n-57e, and this well is also planned as a Devonian test. The well is 75 miles southeast of the new discovery. The Texas Co. is spudding 1 Northern Pacific, C NE NE 35-15n-54e, on Baker-Glendive (Cedar Creek) structure. South of the Cedar Creek anticline, Texas Pacific Coal & Oil Co.-Pure Oil Co. have announced location at 1 Cox, C SW SE 23-3n-61e, an Ordovician test on Plevna anticline.

General Petroleum Corp. recovered oil at the rate of 20 to 30 bbl. per hour on a drill-stem test in the Embar at Manderson, Big Horn County, Wyoming, venture. The well is 1 West, C SE NW 20-50n-92w, and the test was between 7,227-81 ft. with the tool open 75 minutes. Gas was at the surface in 4 minutes with the well flowing oil in 34 minutes. The oil is 38° gravity, with high sulfur content. Top of Embar was logged at 7,211 ft. and the operator is coring ahead in that formation. This well is on a farmout from Pioneer Oil Corp. of Denver, and is located northwest of the Bonanza anticline, where oil was discovered in the Tensleep early this year.

Shell Oil Co. has staked its Horse Track wildcat, 1 Unit, NE NE NE 28-27n-97w, Fremont County, Wyoming. The company plans a stratigraphic drilling program through the area. Yetman-Morton of Casper made location for a 4,000-ft. Tensleep test in the Pitchfork area, NE NW NW 25-48n-103w, Park County. E. N. Hope of Chicago is starting the fourth of a series of wildcats in the Southwest Castle Creek area, Natrona County. In the Paradox area of southwestern Colorado, American Liberty Oil Co. will deepen 1 Federal, C SW SW 10-46n-17w, Montrose County. The well is at 10,545 ft., total depth, and was suspended with 7-in. casing cemented at 8,360 ft. It found more than 8,000 ft. of salt in the Pennsylvanian and was in that formation when suspended. New work in eastern Colorado includes J. B. Stoddard of Dallas 1 State, CE½ SE NE 20-15s-62w, on the south end of the Denver-Julesburg basin, and Carter Oil Co. has announced location for 1 Unit, C NE SW 21-11s-21e, another of the series of basal Green River wildcats, Uintah County, Utah.

COLORADO WILDCAT FAILURES

Lafayette, Adams County: Olds Oil Co. 1 Asher, NE SW NW 4-1s-68w, TD 5,626 ft., dry. Stray sand 3,475 ft., Hygiene 4,920 ft.

Hastey area, Bent County: Deep Rock Oil et al 1 State, SE SW SW 16-21s-49w, TD 5,695 ft., dry. Day Creek 1,530 ft., Blaine 1,766 ft., Harper 2,046 ft., Stone Corral 2,120 ft., Pennsylvanian 3,189 ft., Lansing 3,676 ft., Cherokee 4,236 ft., Mississippian 5,107 ft., Viola 5,488 ft., Arbuckle 5,588 ft.

Holyoke, Phillips County: Suhr, Fielder & Locke-Woodward et al 1 Crow, NW NE NE 19-8n-45w, TD 4,015 ft., dry, Niobrara 2,695 ft., Ft. Hays 2,988 ft., Carlile 3,120 ft., Fairport 3,161 ft., Greenhorn 3,244 ft., "D" sand 3,482 ft., "J" sand 3,565 ft., "M" sand 3,778 ft., "O" sand 3,881 ft., Morrison 3,973 ft.

Riverside, Weld County: Gene Goff 1 State, SE SE SE 23-5n-62w, TD 7,103 ft., dry, Niobrara 5,987 ft., base Timpas 6,267 ft.,

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Anyhow, we folks out here in the wide open spaces at Circleville have the reef all figured out. You just look for the names of counties containing the letter *r* (*r* for reef) like *r* in Scurry, Terry, Borden, Howard, Garza, and then you just sound your *r* again and drill. It is as simple as that, with all due apologies to these highly scientific geological and geophysical professions. Whether you use gravimeter, seismograph or other methods, it is said in order to discover new reserves we must look for oil where others don't, and on looking around there are still *r* counties like Swisher, Hartley, and other counties without *r*'s, with practically unexplored frontiers and untested horizons, where we can offer you acreage or drilling blocks at reasonable prices, or if you prefer, we have the personnel to take a block for you on short notice.

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Eckley area, Yuma County: Service Drilling Co. et al 1 Pletcher, NW NW SE 25-1n-47w, TD 3,917 ft., dry, Niobrara 2,600 ft., Greenhorn 3,291 ft., Skull Creek 3,674 ft., Cloverly 3,781 ft., Morrison 3,912 ft.

WYOMING WILDCAT FAILURE

Alkali Creek, Fremont County: Brinkerhoff Drilling Co. et al 1 "A" Tribal, C NW SE 17-1s-5e (WRM), TD 5,115 ft., dry, Ft. Union 1,774 ft., Mesa Verde 4,990 ft.

SUCCESSFUL COLORADO WILDCATS

Padroni, Logan County: The Texas Co. 1 D. E. Gould, SW SW SW 20-9n-52w, TD 5,214 ft., flowed about 4,000,000 cu. ft. gas per day, Ft. Hays 4,016 ft., Carlile 4,063 ft., Greenhorn 4,282 ft., Graneros 4,290 ft., "D" sand 4,521 ft., "J" sand 4,625 ft., Cheyenne 5,001 ft., Morrison 5,212 ft.

Logan area, Logan County: Plains Exploration Co. 1 Dalke, SE SE SW 22-8n-54w, TD 5,303 ft., swabbed and flowed 12 bbl. oil per hour, Niobrara 4,260 ft., Timpas 4,593 ft., Carlile 4,655 ft., Greenhorn 4,843 ft., Graneros 4,853 ft., "D" sand 5,002 ft., "J" sand 5,195 ft.

UTAH WILDCAT FAILURES

South Burbank, Millard County: Van Glahn 1 J. S. Lee, C NW NE 29-24s-18w, TD 910 ft., dry.

Wahwah Valley, Van Glahn Oil Co. 1 Govt., NE NE SE 33-24s-13w, TD 2,025 ft., dry.

NORTHERN NEW MEXICO WILDCAT FAILURE

San Juan County: British-American Oil Producing Co. 1 T. W. Cabben, NE SW SW 5-26-13w, TD 1,683 ft., dry, Pictured Cliffs 1,418 ft.

Michigan

Bay County Strike Opens New Play

MOUNT PLEASANT.—J. O. Mutch completed a small Dundee oil discovery well this week at the 1 Demary, SW SE SW 20-18n-3e, Gibson Township, Bay County. The wildcat was rated good for 5 to 7 bbl. of oil a day from the Dundee after acid treatments with 1,000 and 2,000 gal. Dundee top was logged at 2,997 ft., and hole was bottomed out at 3,157 ft. Oil pays showed from 3,090-3,120 ft. and the well showed about 100 ft. of free oil in 10 hours, natural. Although this was only a small producer, it was certain to result in further drilling in the area. Mutch was preparing to announce another location in the district this week. The strike appeared to be on structure, and it was believed that further drilling might find better porosity conditions.

Cities Service Oil Co. was coring and testing Traverse objective late this week at the 1 Hansen, NW SW SE 26-11n-7w, Douglas Township, Montcalm County. The well is a diagonal northeast offset to Howard D. Atha's Carlson discovery well which is being produced from the Traverse. The objective zone at the Cities Service test was logged at 2,909 ft. (Alpena Traverse), but no oil saturation had been found in this zone up to 2,975 ft.

Another localized high in Geneva field, Geneva Township, Van Buren County, appeared to have located by Orville Palmer at the 1 Cummings, SW NW SE 27-1s-16w, where Traverse lime was logged at 1,041 ft., and first pay (with no water showing) was logged at 1,043 ft. Operations were shut down at this point to run 5-in. casing before drilling further or running production tests. This well was reported to be checking in about 13 ft. higher structurally than correlating control points.

MICHIGAN SUCCESSFUL WILDCAT

Bay County, Gibson Township: J. O. Mutch 1 Demaray, SW SE SW 20-18n-3e, Dundee 2,997 ft., 7 bbl. oil after acid, TD 3,157 ft.

MICHIGAN WILDCAT FAILURES

Allegan County, Ganges Township: Ford Oil Co. 1 Symons et al, NW SW NE 34-2n-16w, Traverse 1,174 ft., dry, TD 1,179 ft.

Otsego Township: Elkin Palmer & Son 1 Miller, NE NW SW 6-1n-12w, Traverse 1,492 ft., dry, TD 1,496 ft.

Arenac County, Arenac Township: Michigan Oil Co. 1 Payea, SE SE NW 26-19n-5e, Berea 1,644 ft., dry, TD 1,675 ft.

Gladwin County, Gladwin Township: Ogma Development Co., Basin Oil Co., and W. B. Stewart 1 State-Gladwin, NE SE NE 12-19n-1w, Dundee 3,429 ft., dry, TD 3,515 ft.

Kalkaska County, Garfield Township: Sun Oil Co. C-1 Garden, NE NE SW 28-25n-5w, dry in Richfield, TD 4,586 ft.

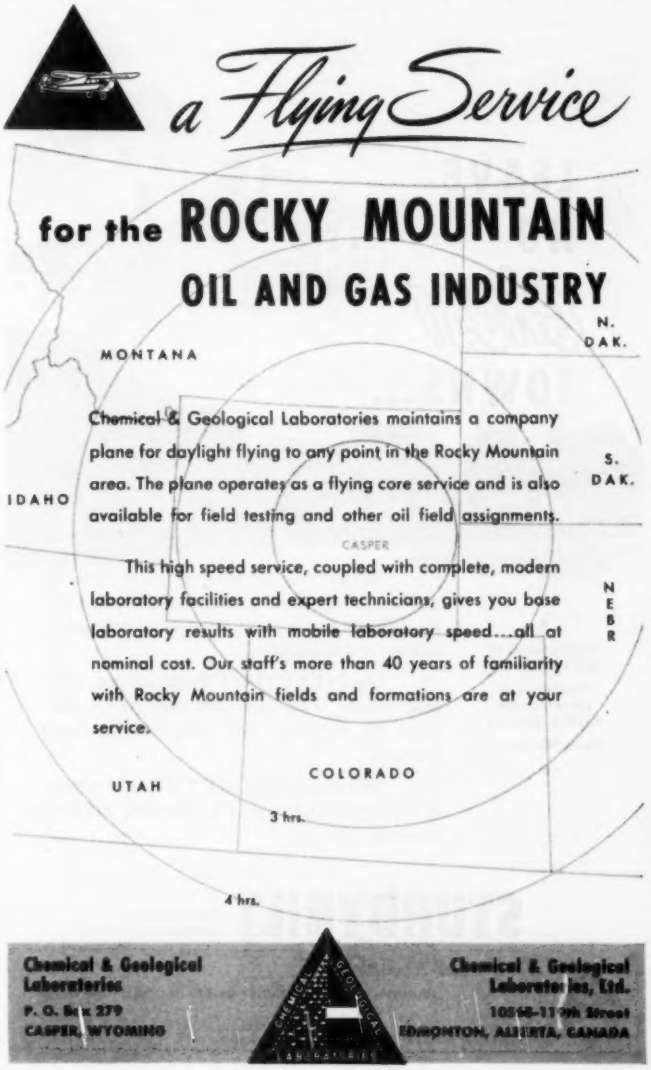
Mason County, Grant Township: The Dow Chemical Co. A-1 Reed, SE SW SW 26-20n-18w, dry in Richfield, TD 2,641 ft.

Van Buren County, Columbia Township: Harris Oil Co. 1 Siggins & Griffindorf et al., NW NE NE 9-1s-15w, Traverse 1,168 ft., dry, TD 1,173 ft.

Illinois-Ind.-Ky.

Aux Vases Well Indicated In Posey County Wildcat

CALVERT DRILLING, INC., and Sam B. Raitman have uncovered what appears to be a promising new pool about midway between Poseyville and Stewartsville in northern Posey County, Indiana. Their 1 Spencer-Vogel, located in the SW SW NE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13-4s-13w, got a good gas flow and filled 1,200 ft. of clean oil in a drill-stem test of saturation found in Aux Vases sand, logged at 2,780-92 ft. Indicated bottom-hole pressure was 1,000 psi. Tester was open 2 hours. Gas was at the surface in 20 minutes. Oil string has been run to 2,779 ft. for completion. The discovery is more than 4 miles from any other production, the nearest being in the East Rogers pool to the southwest.

Opening a new pay zone for the Bufkin area, also in Posey County, Noah Petroleum Co. 1 Walter Droege, SW NW NE 5-6s-12w, swabbed and flowed at the rate of more than 65 bbl. of oil per hour while testing Palestine sand at 1,718-27 ft. Bottom of the hole still is in saturation. Bottom-hole pressure indicated in a previous drill-stem test was 800 psi. The well is ½ mile from other production in the area and more than 7 miles from nearest Palestine sand wells. The area is approximately 8 miles west of Evansville.

Discovery of a Devonian lime pool in the Beaucoup area, 4 miles northeast of Nashville, Washington County, is indicated by results of a drill-stem test by Collins Brothers Oil Co. in their 1 Meinert, NW NE SW 10-2s-2w. The pay, on which casing has been run for completion, was logged at 3,070-80 ft. The test filled 1,230 ft. of clean oil with 10 ft. of water. Tester was open 2 hours. Gas flowed within 11 minutes. The prospective well is a rank wildcat, being more than 6 miles from any other production.

ILLINOIS SUCCESSFUL WILDCATS

Clay County: National Associated Petroleum Co. 1-A Spiker, SW SW SW 7-3n-6e, IP 500 bbl., McClosky 2,894-99 ft., TD 2,899 ft.

Quenzil Webster 1 Webster-Roberts, NE SW SW 26-5n-6e, IP 440 bbl., McClosky 2,782-87 ft., TD 2,790 ft.

Marion County: Atlas Drilling Co. 1 Sawyer, SW SE NW 11-1n-3w, IP 120 bbl., McClosky 2,714-19 ft., TD 2,831 ft.

Richland County: Calvert Drilling, Inc., 1 McVaigh, SW SE NE 16-2n-14w, IP 190 bbl., Rosiclare 3,078-88 ft., TD 3,121 ft. (extends Parkersburg Consolidated pool).

Wayne County: N. V. and Walter Duncan 1 Blackburn, NE NE SE 29-1s-5w, IP 235 bbl., Aux Vases 2,946-56 ft., TD 2,959 ft.

D. H. Bolin 1 Clevenger, SE NE NE 36-1s-5e, IP 133 bbl., McClosky 3,165-68 ft., TD 3,168 ft.

White County: Noah Petroleum Co. 1 Winter, SW SE NW 25-4s-9e, IP 165 bbl., Tar Springs 2,537-47 ft., TD 2,547 ft.

ILLINOIS WILDCAT FAILURES

Bond County: A. S. Reed 1 Haberer, NE SE NE 22-5n-3w, dry, TD 2,275 ft.

Christian County: Don Baines 1 Bellsmith, SW SE NE 11-15n-2w, dry, TD 1,970 ft.

Clark County: Ward W. Dayton, SE NW NE 30-11n-10w, dry, TD 2,053 ft.

Clay County: George & Wrather 1 Builes, NW SE NW 35-3n-5e, dry, TD 3,043 ft.

Clinton County: Mark Twain Oil Co. 1 DuComb, SW SW NW 6-1n-2w, dry, TD 2,604 ft.

(Continued on page 398)

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Louisiana-Arkansas

Concordia Parish Has First 1951 Discovery

SHREVEPORT.—Concordia Parish got its first discovery of this year when H. L. Hunt's wildcat east of Lismore flowed at the rate of 125 bbl. of oil daily on a 1-hour drill-stem test of the Wilcox at 5,291-94 ft. Located 1,980 ft. from the south and 1,970 ft. from the west lines of Section 15-6n-7e, the well has 7-in. casing set to 5,350 ft., total depth is 7,003 ft.

Sohio Petroleum Co. and Pan-Am Southern Corp. have opened a new field 12 miles east of Marksville in Avoyelles Parish. The 1 Bordelon, 3300 ft. north and 200 ft. west of the southeast corner of 36-2n-5e, flowed 109 bbl. of oil daily on drill-stem test of the Wilcox at 8,407-11 ft. Gravity of the crude was 49°. Total depth is 9,005 ft. with 5½-in. string set to 8,480 ft.

In DeSoto Parish, Lacy, Inc., ran 5½-in. pay string to 6,405 ft. at 1 Lacy-Baxter, wildcat 660 ft. north and east of the southwest corner of 33-13n-16w. Tests had recovered 150 ft. of gas-cut mud from the Travis Peak around 6,350-6,410 ft. Total depth is 6,462 ft.

Skelly Oil Co.'s Webster Parish wildcat proved disappointing in the Cotton Valley tested at 6,854-89 ft. The well, 1 E. L. Stewart, 19-19n-10w, is currently coring below 6,900 ft. Further up the hole, it had 2,700 ft. of oil on a drill-stem test of the Pettit at 4,002-13 ft.

In Union County, Arkansas, Pan-Am Southern 1 Ezzell, 590 ft. from north and east lines, SW NE 13-17s-15w, cored 5 ft. of sand below 2,580 ft. The test is drilling and coring below 2,600 ft.

NORTH LOUISIANA WILDCAT FAILURES

Catahoula Parish: Hunt and Gulf 40 Louisiana Delta Lumber, 1,980 ft. S and W NEc 31-4n-5e, dry, TD 7,500 ft.

Marine Oil 1 C. P. McGraw, 660 ft. S and E NWC NW SW 21-9n-9e, dry, TD 6,301 ft.

LaSalle Parish: Hunt and Gulf 43 Louisiana Delta Lumber, C NW SE 26-7n-4e, dry, TD 5,286 ft.

Natchitoches Parish: W. C. Feazel et al 1 Scarborough - Carver, 4,000 ft. N and 4,500 ft. E SWc Sec. 11 in Sec. 37-9n-8w, dry, TD 5,003 ft.

ARKANSAS WILDCAT FAILURE

Nevada County: Burnett 1 E. P. Halton "A," C NE SW 23-14s-20w, dry, TD 3,953 ft.

May Passes June as Peak Completion Month; Well Depths Show Steady Rate of Increase

by Polly DeArmond

FOR the first time since 1947, June failed to set the record for completions during the first half period, despite indications that the year 1951 is forging ahead to all-time drilling highs. *(See completions report in Mid-Year Review section of this issue.)*

June also marked the second instance since World War II that it was not the peak month for new wells in the January-June period. For both 1947 and this year, May was credited with the greatest number of wells drilled for the period.

The steady increase in depths to which wells are being carried is clearly apparent in analyses of operations for postwar years. Although these comparisons are, at this writing, for the month of June in each respective case, the resulting "yardstick" is applicable to practically all such comparisons—monthly, quarterly, semi-annually, annually—for the period considered.

1950.—A comparison of June with the same month of last year shows that total completions were off 335 wells, or 8.2 per cent; footage dropped 865,119 ft., or 5.8 per cent; average footage per well increased from 3,632 ft. to 3,726 ft.

1949.—June 1951 had a slight edge over June 1949 in wells, up 23 or 0.6 per cent, and footage, up 499,467 or 3.7 per cent. Average depth jumped 111 ft.-per-well from 3,615 ft.

1948.—Completions increased 446 wells, or 13.6 per cent, and footage climbed 2,998,925 ft., or 27.5 per cent. Average depth jumped 406 ft.-per-well from 3,320 ft. in June 1948.

1947.—Statistics for this June vs. June 1947 reflect that wells were up 37.9 per cent (1,026 holes) and footage increased 51.3 per cent (4,718,696 ft.), while average footage was up 330 ft.-per-completed-well.

1946.—The greatest gain in average depth per well is noted in this comparison; in June 1946 it was 3,249 ft. for each completion as against the current June's 3,726 ft. The number of wells was up 1,144, or 44.2 per cent, and total footage increased 5,303,075 ft., or 63 per cent.

1945.—Operators finished 1,283 more wells during last June than in the corresponding month of 1945 (an increase of 52.3 per cent), with an accompanying gain of 4,422,669 ft. (52.1 per cent) in footage. Average depth was up 261 ft. from the mean proportion per well in 1945.

SUMMARY OF COMPLETIONS . . . JUNE 1951

	Total comp.	Oil	Gas	Dry	Under 2,500 ft.	2,500-5,000 ft.	5,000-7,500 ft.	7,500-10,000 ft.	10,000-12,500 ft.	Over 12,500 ft.	Total footage	Rigs and drilling
New York	70	35	0	35	70	0	0	0	0	0	103,000	51
Pennsylvania	174	83	18	73	164	3	7	0	0	0	312,070	198
West Virginia	40	6	26	8	20	18	2	0	0	0	111,738	169
Maryland	5	0	4	1	0	4	1	0	0	0	21,465	29
Ohio	77	26	22	29	47	30	0	0	0	0	155,680	156
Kentucky	130	56	8	66	112	18	0	0	0	0	218,033	93
Illinois	237	71	0	166	69	167	1	0	0	0	643,939	259
Indiana	128	51	0	77	100	28	0	0	0	0	228,871	217
Michigan	89	24	3	62	50	39	0	0	0	0	226,350	120
Kansas	373	180	39	154	42	326	5	0	0	0	1,226,594	471
Neb., Mo., Iowa	13	6	0	7	1	9	3	0	0	0	61,860	24
Oklahoma	429	259	20	150	138	191	72	17	10	1	1,002,047	834
Texas	1,338	803	52	483	310	505	371	126	24	2	6,031,407	1,571
North	219	120	2	97	82	96	41	0	0	0	731,881	197
West Central	201	84	1	116	85	87	29	0	0	0	628,033	188
West	385	312	0	73	57	96	181	40	10	1	2,068,300	569
Panhandle	47	25	19	3	7	39	0	1	0	0	144,353	103
East	117	78	3	36	21	59	22	15	0	0	506,099	76
Gulf Coast	196	92	15	89	14	60	58	52	11	1	1,185,041	235
Southwest	173	92	12	69	44	68	40	18	3	0	767,700	203
Louisiana	186	99	16	71	50	47	25	23	36	5	1,060,163	272
Northern	112	57	14	41	49	40	16	5	2	0	364,939	114
Southern	74	42	2	30	1	7	9	18	34	5	695,224	158
Arkansas	37	20	0	17	13	21	1	2	0	0	119,982	35
Mississippi	32	15	1	16	1	9	12	8	2	0	206,706	32
Ala., Ga., Fla.	3	1	0	2	0	1	1	1	0	0	18,874	6
Montana	26	17	1	8	21	4	1	0	0	0	60,500	65
Wyoming	81	55	3	23	5	48	20	7	1	0	408,654	223
Colorado	28	12	0	16	2	4	21	1	0	0	142,381	71
Utah	1	0	0	1	1	0	0	0	0	0	2,162	30
New Mexico	47	19	19	9	6	19	10	9	0	3	250,165	147
California	191	137	2	52	68	79	27	12	4	1	705,334	243
Dakotas	0	0	0	0	0	0	0	0	0	0	0	¶15
Total June 1951	3,735	†1,975	234	*1,526	1,290	1,570	580	306	77	12	13,917,977	‡5,329
Total May 1951§	3,960	2,074	260	1,626	1,286	1,676	623	244	109	22	15,410,041	5,493
Total June 1950	4,070	2,334	282	1,454	1,480	1,649	626	208	95	12	14,783,096	5,118
Cumulative 1951	20,632	11,194	1,331	8,107	6,739	8,707	3,340	1,206	549	91	79,732,958	....
Cumulative 1950	20,216	11,693	1,351	7,172	7,357	8,033	3,228	1,062	470	66	74,569,711	....

*Incl. 146 service wells: N.Y. 35, Pa. 68, Ohio 7, Ill. 1, Mich. 8, Kans. 4, Okla. 20, No. Tex. 1, E. Tex. 1, Calif. 1. †Incl. 38 distillate wells: Okla. 10, No. Tex. 2, W. Tex. 1, E. Tex. 6, Tex. Gulf 9, S.W. Tex. 1, No. La. 1, So. La. 7, Miss. 1. ‡Incl. all wells rigged up and/or drilling at month end. §Revised. ¶Incl. 4 Nev. and 1 Idaho.

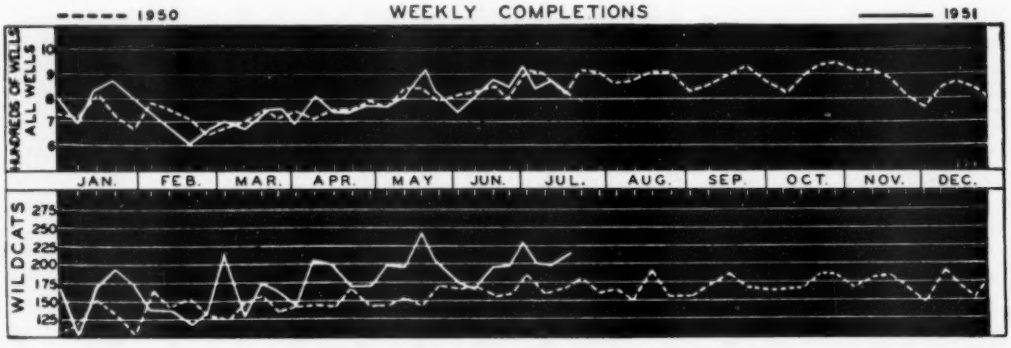
CURRENT STATISTICS

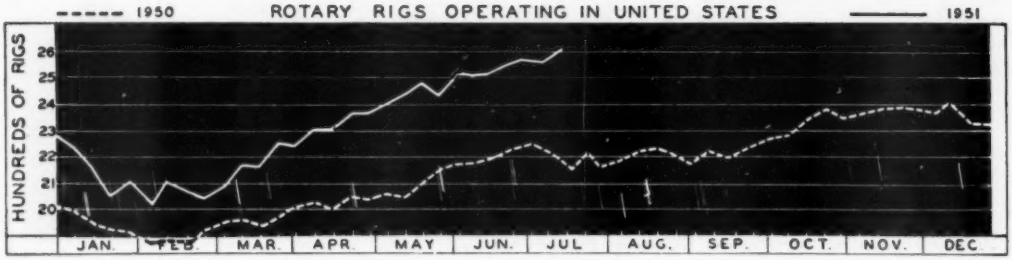
EXPLORATION

WEEKLY WELL COMPLETIONS . . . . WEEK ENDED JULY 21, 1951

	Total of all wells					July 21		Wildcat completions and discoveries									
								Cumulative total, 1951									
	Comp.	Oil	Gas	Dry	Footage	1951	1950	Oil	Dist.	Gas	Dry	Total	Oil	Dist.	Gas	Dry	Total
New York	13	7	0	*6	18,831	263	271	0	0	0	0	0	0	0	0	0	0
Pennsylvania	14	6	2	†6	24,889	395	514	0	0	0	0	0	0	0	0	1	1
West Virginia	7	0	7	0	25,199	301	363	0	0	0	0	0	0	0	0	6	5	11
Ohio	15	9	1	‡5	32,545	484	535	0	0	0	0	0	1	0	4	15	20
Indiana	31	13	1	17	60,525	638	808	3	0	0	4	7	20	0	1	162	183
Kentucky	28	7	10	11	68,839	603	533	0	0	0	0	0	13	0	1	101	115
Illinois	60	23	0	37	167,216	1,143	1,451	7	0	0	21	28	35	0	0	262	297
Michigan	17	4	0	13	41,253	410	475	1	0	0	7	8	15	0	6	162	183
Kansas	94	39	10	§45	314,799	2,334	2,009	4	0	1	27	32	118	0	10	468	596
Nebraska	2	2	0	0	9,111	136	57	0	0	0	0	0	4	0	1	59	64
Oklahoma	86	46	2	§38	295,894	3,021	2,949	2	0	0	11	13	107	2	15	389	513
Texas	304	181	12	111	1,386,883	9,092	8,911	18	1	4	70	93	400	34	72	1,803	2,309
North Central (Dist. 7-B & 9)	91	53	1	‡37	333,525	2,773	2,748	12	0	1	19	32	199	2	9	771	981
West (Dist. 7-C & 8)	80	61	1	18	423,502	2,723	2,587	1	0	0	13	14	87	8	5	339	439
Panhandle (Dist. 10)	16	11	2	3	52,622	378	527	0	0	0	1	1	2	0	0	14	16
Eastern (Dist. 5 & 6)	21	12	0	9	77,698	673	636	1	0	0	7	8	5	4	0	121	130
Gulf Coast (Dist. 2 & 3)	44	21	5	18	269,671	1,287	1,242	1	0	1	11	13	56	14	37	262	369
Southwest (Dist. 1 & 4)	52	23	3	26	229,865	1,258	1,171	3	1	2	19	25	51	6	21	296	374
Louisiana	33	12	1	20	228,287	1,106	1,356	0	0	0	7	7	24	3	4	142	173
Northern	19	5	1	13	89,232	576	706	0	0	0	4	4	7	0	3	81	91
Southern	14	7	0	7	139,055	530	650	0	0	0	3	3	17	3	1	61	82
Arkansas	9	5	0	4	33,607	210	226	0	0	0	1	1	8	0	2	40	50
Mississippi	8	5	0	3	53,855	173	176	1	0	0	0	1	7	3	0	57	67
Southeastern States	0	0	0	0	0	36	35	0	0	0	0	0	0	0	0	14	14
Montana	1	1	0	0	3,062	123	111	0	0	0	0	0	0	0	0	27	27
Wyoming	20	16	0	4	99,552	396	311	0	0	0	1	1	7	0	0	53	60
Colorado-Utah	12	4	1	7	49,763	148	46	1	0	1	7	9	5	0	4	74	83
New Mexico	18	1	12	5	68,145	372	346	1	0	0	5	6	9	0	7	45	61
California	41	32	0	9	189,966	1,201	963	1	0	0	8	9	27	0	1	237	265
Miscellaneous (Md.)	1	0	1	0	3,600	28	9	0	0	1	0	1	0	0	17	10	27
Total United States	814	413	60	341	3,175,821	22,619	22,455	39	1	7	169	216	800	42	151	4,126	5,119
Total previous week	875	456	47	372	3,140,131	....	....	28	1	5	157	191	761	41	144	3,957	4,903
Total July 21, 1950	917	498	61	358	3,352,748	....	....	25	1	1	151	178	584	42	109	3,376	4,111

Service wells included: *6, †5, ‡1, §2.





DAILY AVERAGE PRODUCTION FOR WEEK

	July 21 crude oil	B. of M. July demand	July 14 crude oil
Alabama	3,100	2,400	3,150
Arkansas	76,600	85,000	75,550
California	977,500	980,000	973,200
Colorado	71,600	80,000	73,100
Eastern	60,850	64,000	56,200
Florida	1,650	1,600	1,500
Illinois	171,300	162,000	167,800
Indiana	29,500	29,000	30,500
Kansas	293,600	315,000	305,400
Kentucky	28,900	29,000	29,100
Louisiana	611,725	652,000	610,975
North Louisiana	114,150	.....	113,400
South Louisiana	497,575	.....	497,575
Michigan	37,900	42,000	37,900
Mississippi	99,950	104,000	100,450
Montana	23,200	24,000	23,000
Nebraska	6,350	10,000	6,500
New Mexico	147,125	146,000	147,125
Oklahoma	508,050	521,000	504,250
Texas	2,744,750	2,580,000	2,744,750
Dist. 1 (Southwest)	33,050	.....	33,050
Dist. 4 (Southwest)	253,275	.....	253,275
Dist. 2 (Gulf Coast)	160,625	.....	160,625
Dist. 3 (Gulf Coast)	470,825	.....	470,825
Dist. 5 (Eastern)	54,625	.....	54,625
Dist. 6 (Eastern)	115,800	.....	115,800
East Texas field	271,300	.....	271,300
Dist. 7-C (West)	101,100	.....	101,100
Dist. 8 (West)	957,000	.....	957,000
Dist. 7-B (W. Central)	81,875	.....	81,875
Dist. 9 (N. Central)	157,750	.....	157,750
Dist. 10 (Panhandle)	87,525	.....	87,525
Utah	4,100	5,000	4,000
Wyoming	195,200	178,000	194,500
Total United States	*6,092,950	6,010,000	6,088,950
Change from previous week, up	4,000		
Canada	165,340	.....	167,975

Total U. S. production January 1-July 21 ..... †1,197,719,000 bbl.
Same period last year (crude plus cond.) ..... 1,031,895,765 bbl.

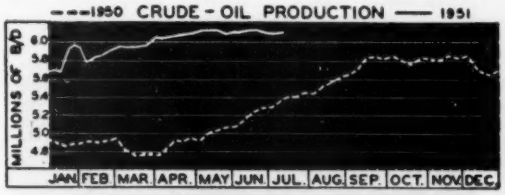
*Not including 99,630 bbl. condensate. †Including 21,444,395 bbl. condensate.

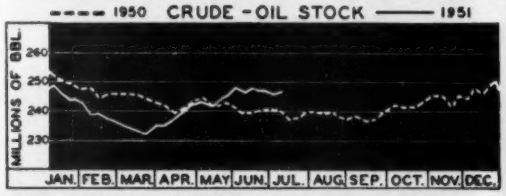
CRUDE-OIL STOCKS BY STATES OF ORIGIN*

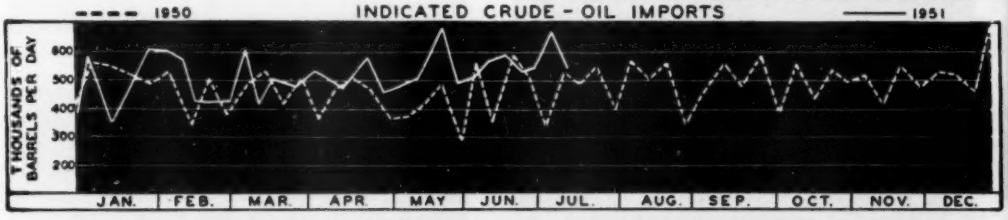
(Thousands of barrels)

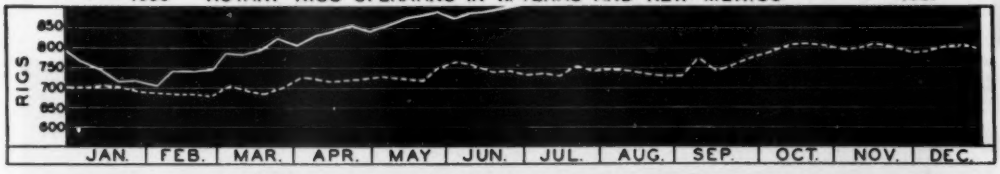
	July 14, 1951	July 7, 1951	July 15, 1950
Pennsylvania Grade	2,131	2,111	2,754
Other Appalachian	1,517	1,335	1,579
Illinois, Indiana, Michigan	11,050	11,269	9,071
Arkansas	2,874	2,848	2,808
Louisiana	14,280	14,384	15,202
North	2,864	3,011	3,118
Gulf	11,416	11,373	12,084
Mississippi	3,102	2,809	2,394
New Mexico	6,605	6,205	6,188
Oklahoma and Kansas	37,431	37,099	33,126
Texas	115,574	114,479	112,098
East Texas	13,954	14,685	15,682
West Texas	48,529	48,172	41,250
Texas Gulf	25,909	24,714	27,693
Other Texas	27,182	26,908	27,473
Rocky Mountain	13,964	13,784	12,220
California	30,391	30,462	34,536
Foreign	8,845	9,030	6,509
Total	247,765	245,815	238,485

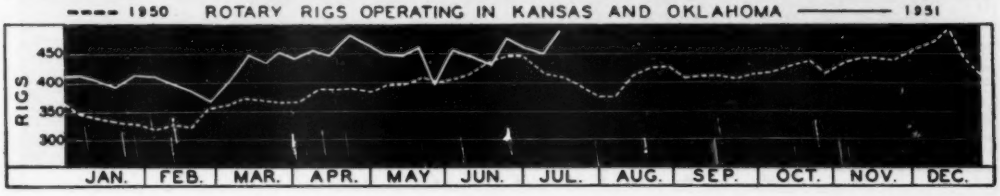
*Bureau of Mines.









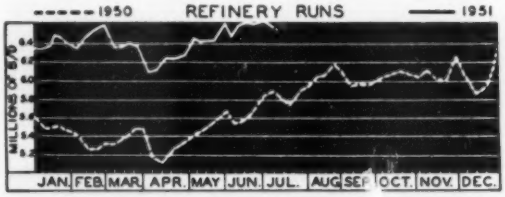


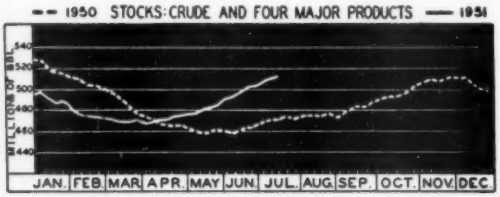
A.P.I. REFINERY REPORT, JULY 14

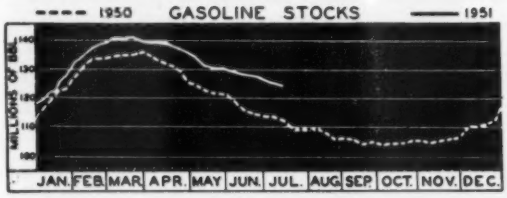
(Thousands of barrels)

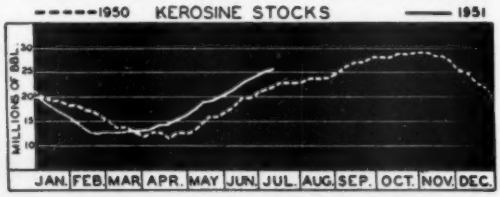
District—	Daily avg. crude runs	Daily average production: Gasoline*	Kerosine	Distillate	Residual	Stocks at refineries, bulk terminals, in transit and in pipe lines: Gasoline†	Kerosine	Distillate	Residual	Bureau of Mines, July 1950: Daily avg. crude runs	Daily average production: Gasoline*	Kerosine	Distillate	Residual
East Coast	1,001	418.3	34.1	203.1	204.0	27,572	9,724	22,071	10,880	964	402.1	34.3	192.9	213.7
Appalachian:														
District 1	105	42.7	4.9	14.6	16.9	2,979	572	889	320	98	44.6	5.1	12.7	10.2
District 2	75	30.3	3.1	10.3	11.0	1,302	277	376	218	71	32.8	3.1	8.3	14.3
Ind., Ill., Ky.	1,254	635.3	79.1	200.3	153.7	27,838	5,424	15,787	4,651	1,090	585.6	53.2	159.8	144.8
Okla., Kans., Mo.	546	297.7	18.3	129.7	69.3	14,300	1,436	8,303	1,662	522	284.9	16.2	106.2	54.7
Inland Texas	252	161.2	14.3	43.3	43.0	3,211	428	1,306	889	214	137.2	10.8	30.2	42.3
Texas Gulf Coast	1,555	730.4	127.4	345.0	231.2	17,827	4,848	9,174	4,605	1,267	595.0	100.3	245.1	229.8
La. Gulf Coast	507	245.7	32.3	128.6	71.6	6,269	2,002	3,754	1,767	487	227.9	47.9	105.1	58.5
N. La. and Ark.	82	32.4	7.9	27.3	7.9	2,531	393	811	107	74	28.4	6.9	13.9	12.3
Rocky Mountain:														
New Mexico	13	8.7	.....	3.0	3.4	118	.....	60	30	14	7.4	.3	2.2	3.6
Other Rocky Mtn.	229	106.6	5.0	44.6	46.0	5,243	327	1,651	1,102	196	85.3	5.0	38.2	33.6
California	940	422.4	10.0	92.4	387.8	14,967	430	8,124	17,008	885	403.4	10.2	125.8	220.1
July 14, 1951	6,561	3,140.7	337.4	1,242.2	1,290.4	124,157	25,863	72,306	43,239	5,882	2,834.6	293.3	1,040.4	1,139.9
July 7, 1951	6,601	3,119.6	325.1	1,287.7	1,329.7	126,758	25,446	69,608	42,857	.....	.....	.....	.....	.....
July 15, 1950	5,806	2,758.7	306.7	1,025.6	1,146.6	111,739	22,332	58,658	42,708	.....	.....	.....	.....	.....

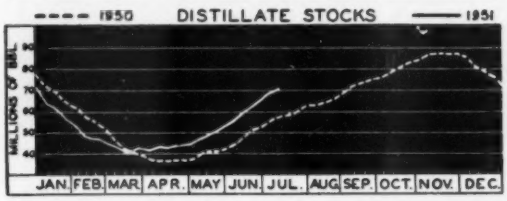
*At refineries including natural blended. †Finished and unfinished.

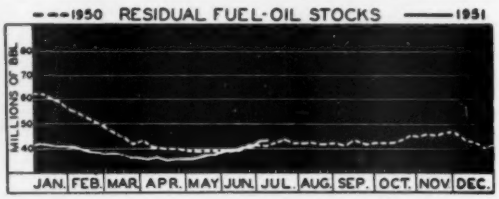


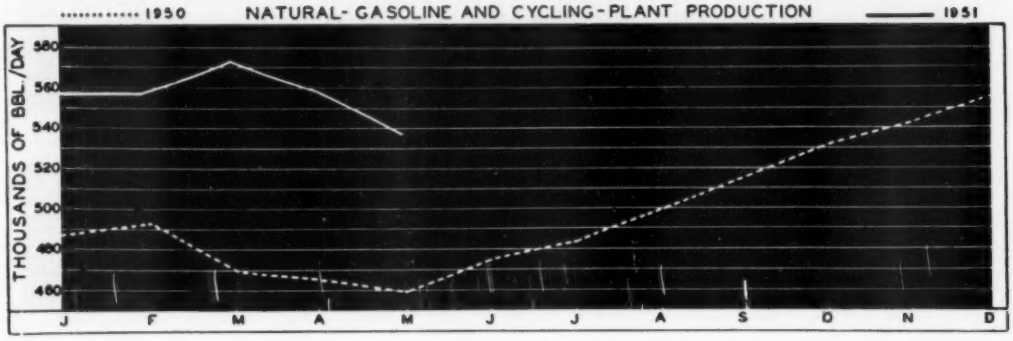












CRUDE PRICES GRAVITY SCHEDULE

	Signal Hill, Calif.‡	Oklahoma, Kansas	Gulf Coast Tex.*	West Tex.†
18-18.9	$1.93	....	....	....
19-19.9	1.98	....	....	....
20-20.9	2.03	$2.25	....	$2.12
21-21.9	2.07	2.27	....	2.14
22-22.9	2.12	2.29	....	2.16
23-23.9	2.18	2.31	....	2.18
24-24.9	2.24	2.33	$2.56	2.20
25-25.9	2.30	2.35	2.58	2.22
26-26.9	2.36	2.37	2.60	2.24
27-27.9	2.41	2.39	2.62	2.26
28-28.9	2.46	2.41	2.64	2.28
29-29.9	2.52	2.43	2.66	2.30
30-30.9	2.57	2.45	2.68	2.32
31-31.9	2.62	2.47	2.70	2.34
32-32.9	2.68	2.49	2.72	2.36
33-33.9	....	2.51	2.74	2.38
34-34.9	....	2.53	2.76	2.40
35-35.9	....	2.55	2.78	2.42
36-36.9	....	2.57	2.80	2.41
37-37.9	....	2.59	2.82	2.46
38-38.9	....	2.61	2.84	2.43
39-39.9	....	2.63	2.86	2.50
40 and above	....	2.65	2.88	2.52

*For crude from Daboval, El Campo, and Sand Point.

†Includes Lea County, New Mexico. Last general price change represented a 50-cent increase becoming effective December 6, 1947.

‡Standard Oil Co. of California.

FLAT CRUDE PRICES

Representative posted schedules per barrel.	
East Texas†	$2.65
Kettleman Hills, California*	2.80
Beauregard Parish	2.60
Illinois Basin	2.77
Pecos County, Texas (Yates)	2.35
Bradford, Pennsylvania	4.25
Eastern Ill. and Western Ind.†	2.77
Tomball, Texas Gulf Coast	2.83

*37°-37.9°. †35° and above.

TOTAL gasoline stocks decreased more for the week ended July 14 than in the 4-week period ended July 7. Despite near-record refinery production of motor fuel, total gasoline stocks dropped 2,601,000 bbl. during the week. This is the first normal reduction since the middle of May. Except for scattered price wars at service stations, mostly on the East Coast, gasoline prices have remained firm.

Floods in eastern Kansas and parts of Missouri have tended to cut refinery runs in the Mid-Continent. A few of the plants located in the flood areas were under water, but the drop in product movement by pipe lines has been a major factor in limiting runs. At the height of the flood at Kansas City, pumping facilities of the Great Lakes pipe line were out, and product movement through the line was discontinued until river crossings could be checked. Limited movement was started after the line was found to be intact, but the pipeline company had to cut product tenders, particularly light distillates. Since tank-car shipments could not take up the slack, some of the refineries that normally move a high percentage of light products through the line had to reduce runs until line movement is back to near normal.

There have been rumors of tank-car shipments of residual fuel from the Group 3 area to the Gulf Coast. Since the heavy-fuel market in the Mid-Continent is firm for this time of the year, most marketers can't understand how a top of $1.90 at the Gulf can give an acceptable net at a Mid-Continent refinery.

Office of Price Stabilization has received requests for price relief on No. 2 fuel from several independent cargo suppliers in the New York Harbor area. Increases requested ranged from 0.5 cent to 1.9 cents a gallon. The Gulf-East Coast differential is now about 1 cent a gallon or less than actual tanker costs for the movement.

REPRESENTATIVE QUOTATIONS

Representative spot-market quotations of leading suppliers as of July 23, 1951. Figures are f.o.b. plant for tank-car shipments in cents per gallon, except for residual fuel oil which shows the price per barrel and wax, in cents per pound.

GASOLINE, KEROSINE, AND FUEL OILS

	Mid-Continent Group 3	New York Harbor (barge)	Texas Gulf Coast
Regular gasoline, 80-82 octane	10¼-10½	12-12.75	10¾-11
Premium gasoline, 86-88 octane	11¼-11½	13.5-13.75	11¾-12
42-44 w.w. kerosine	9-9⅜	10	9
No. 2 straw fuel oil	8-8⅜	9	8
No. 6 residual	$1.75-1.80	$2.45-2.60	$1.75-1.90

NATURAL GASOLINE

	Group 3	North Texas	N. La.
Grade 26-70	5½	5	5¼
Grade 18-55	6.6	6.1	6.35

LUBRICATING OILS

South Texas

200 vis., No. 2-3 neutral	13-13.5
750 vis., No. 3-4 neutral	16
2,000 No. 5-6 neutral	18-19

LUBRICATING OILS

Mid-Continent

150-160 vis., D bright stock, 0-10 pp.	29-30
200 vis., No. 3 neutral, 0-10 pp.	17.5-18.5

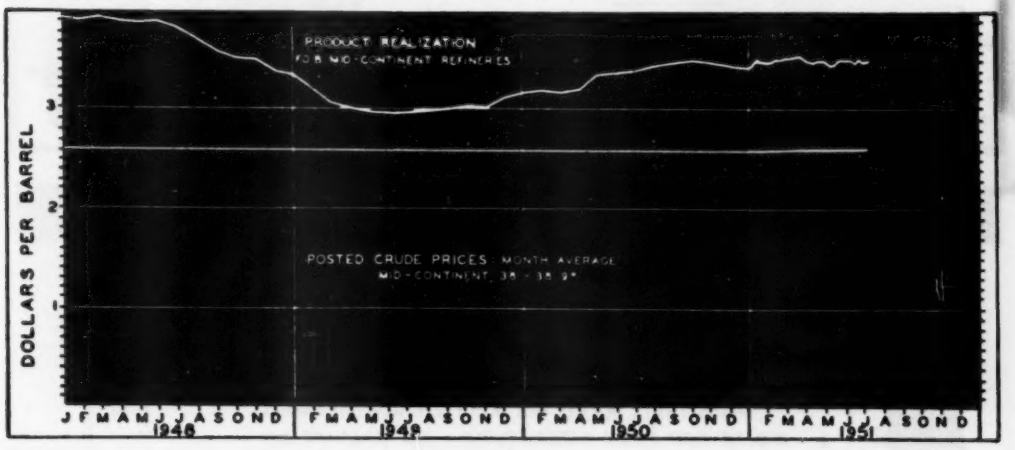
Western Pennsylvania

145-155 vis., 10 p.t. bright stock	32.5
180 vis., 0 p.t. neutral	31.5

WAX

Mid-Continent

132-134 A.M.P.	6.6


PRODUCT REALIZATION
FOR MID-CONTINENT REFINERIES
POSTED CRUDE PRICES, MONTH AVERAGE
MID-CONTINENT, 38° - 38.9°
DOLLARS PER BARREL
3
2
1
J F M A M J J A S O N D
1948
F M A M J J A S O N D
1949
F M A M J J A S O N D
1950
F M A M J J A S O N D
1951

In this trend chart refinery realization is based on average Mid-Continent grade crude oil (not 31° gravity only) and average prices for refinery products as published in The Oil and Gas Journal basis Oklahoma (Group 3). Refinery yields confined to gasoline, kerosine, distillate, and fuel oil. Realization averaged $3.52 for week ended July 14, $3.47 for previous week, and $3.43 for July 1950.

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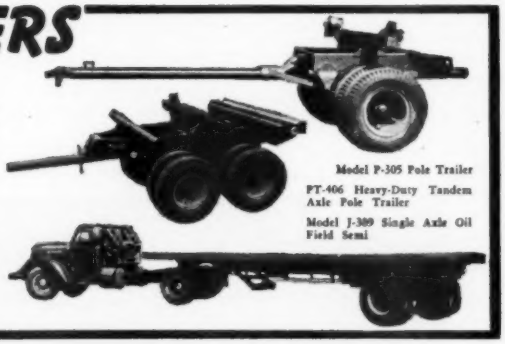

Model P-305 Pole Trailer

PT-406 Heavy-Duty Tandem Axle Pole Trailer

Model J-309 Single Axle Oil Field Semi

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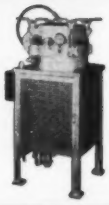

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EQUIPMENT MEN . . . in the News

Petty Geophysical Firm Elects New Officers

O. SCOTT PETTY

Petty Geophysical Engineering Co. has elected new officers and directors from outside the organization for the first time in its 26-year history. Officers elected were: O. Scott Petty, chairman of the board; P. J. Rudolph, president and general manager; Weldon L. Crawford, executive

P. J. RUDOLPH

W. L. CRAWFORD

vice president and treasurer; Van A. Petty, Jr., vice president and secretary; and W. Lee Moore, vice president.

V. A. PETTY, JR.

W. LEE MOORE

Scott Petty, the new chairman of the board, has been president since the company was founded in 1925.

Officers retiring after 26 years of active service are: Dabney E. Petty, vice president; and Mrs. Edwina H. Petty, secretary. Elected to serve as directors were: O. Scott Petty, Dabney E. Petty, Van A. Petty, Jr., P. J. Rudolph, Weldon L. Crawford, W. Lee Moore, and Arthur L. Lay.

The same group of officers and directors will also serve Petty Laboratories, Inc., which builds Petty's equipment, and Petty Geophysical Co., which conducts its foreign operations.

Petty Geophysical Engineering Co. was founded in 1925 by three brothers, Dabney E. Petty, O. Scott Petty, and the late Van A. Petty, with the assistance and cooperation of their father, the late V. A. Petty, Sr. It is now employing 500 men, and its operations are world wide.

Collins Joins Iverson As Vice President

T. D. COLLINS

S. J. Iverson, president of Iverson Supply Co., Tulsa, has appointed T. D. (Hi) Collins vice president and general manager.

Collins is a veteran of more than 20 years in the oil-field-supply business, and was formerly vice president of International Derrick & Equipment Co., supply-store division, and a member of the board of directors. Prior to joining Ideco, he was associated with Continental Supply Co., commencing his service with that company at Ranger, Tex. While with Continental he was in charge of the West Texas, North Texas, and New Mexico division, and also represented Continental as division manager of the Rocky Mountain area.

Lucey Reestablishes Its Pipe-Exchange Service

Lucey Products Corp. has announced reestablishment of its Pipe-Exchange Service, to aid operators in securing tubular goods of certain sizes, weights, and grades.

The company inaugurated this service back in 1947, and, due to the difficulty now being encountered in obtaining various tubular goods to carry on oil-field operations, the firm is again offering the service without profit to the company.

Lucey said that it is handling all standard makes of leading oil-country materials sold other than on an exclusive basis, including pumping and floating equipment, sucker rods, pumping units, christmas trees, control heads, packers, swabs, drilling equipments, bits, wire lines, roller chain, blocks, tongs, slush-pump pistons, rods, and liners.

The Pipe-Exchange Service will include sending "tip sheets" to 3,000 different oil operators and drilling contractors on material available through the service.

Schlumberger Announces Organizational Changes

W. J. GILLINGHAM

W. J. Gillingham has been appointed executive vice president of Schlumberger Well Servicing Corp., replacing Roger Henquet, who recently resigned.

A. Vennema has been promoted to the newly created position of vice president in charge of personnel relations, and Allen Morazzani has been promoted to manager of the northeast area (Illinois, Kentucky, Michigan, and Appalachian region).

Gillingham has been affiliated with Schlumberger companies since 1934; Vennema has worked for the firm since 1937; and Morazzani came to the United States in 1937 after service in other parts of the world.

WECO Appoints Jordan Assistant Sales Manager

F. A. JORDAN

Foster A. Jordan has been appointed assistant sales manager of Well Equipment Manufacturing Co., succeeding John W. Gates, who has been made sales manager.

For the past year Jordan has been representing the company in the West Texas-New Mexico territory. He has been with the WECO sales organization for the past 6 years, during which time he has represented the company on the Gulf Coast, in northern Louisiana, and in Central Texas before moving to West Texas.

J. C. McCelvey and L. L. Durkin are being transferred to the West Texas-New Mexico territory as WECO representatives.

Dresser Streamlines IDECO Management

Completion of the formation of a new organization known as Dresser Equipment Co. has been announced by H. N. Mallon, president of Dresser Industries, Inc., Dallas.

The new company is composed of two former Dresser Industries' subsidiaries, Kobe, Inc., and International

Derrick & Equipment Co. These two organizations will function as the Kobe division and Ideco division of Dresser Equipment Co.

Kobe will be a complete operating unit. Ideco will operate its three manufacturing plants located at Columbus, Ohio; Beaumont, Tex.; and Torrance, Calif., as separate units under their own general managers. These Ideco general managers will have complete charge of each individual plant's administration and will report directly to John B. O'Connor, who has been elected president of Dresser Equipment Co., in addition to being executive vice president of Dresser Industries, Inc.

Cummins Sales Opens New Diesel Store in Texas

Cummins Sales & Service, Inc., operating 10 diesel service shops in the Southwest, has announced the opening of its eleventh shop at Pharr, Tex.

The new building is of steel and stone construction and contains a display room and offices, complete parts room and service area, and a large truck port. The main building is 40 by 100 ft. and the truck port measures 50 by 50 ft.

The store personnel is under the guidance of District Service Manager R. G. Barnes, former sales engineer at New Orleans. Otis E. Farley, transferred from the same position at Shreveport, is the new store manager. V. J. Mickell, from the Houston store; W. F. Wade, from the store at Great Bend, Kans.; and Troy L. Weaver are mechanics at the new shop. Juan Salinas is parts man.

Other Cummins shops are located in Texas at Fort Worth, Houston, Odessa, Abilene, and Wichita Falls, in Kansas at Wichita and Great Bend; in Oklahoma at Oklahoma City; and in Louisiana at Shreveport and New Orleans.

New Continental Store

The new Continental Supply Co. store at Farmington, N. M., will serve the territory comprising northwestern New Mexico, southwestern Colorado and southeastern Utah.

C. A. Ross has been named as store manager. This point is under the direct supervision of W. T. Hays, assistant district manager, Midland, Tex.; and R. L. Collier, district manager, Fort Worth.

Link Appointed Valve Engineer for Rockwell

JOHN B. LINK

H. Boezinger, Pacific Coast district manager at Rockwell Manufacturing Co., has announced the appointment of John B. Link as valve engineer for the southern California area. In his new position Link will be responsible for the sale of valves used by oil refineries and engineering companies in the area.

Prior to his recent Rockwell appointment, Link was a member of the apparatus sales division of Southwestern Engineering Corp., and also served as San Francisco sales representative for C F Braun & Co.

Illinois Fields

(Continued from page 390)

E. A. Obering 1 Baum, NW SE NW 21-3n-2w, dry, TD 1,464 ft.

E. F. Jones 1 Hummert, SEc NW SW SW 36-3n-4w, dry, TD 2,330 ft.

Edwards County: Aurora Gasoline Co. 1 H. W. Mason-Illinois Bankers, SW SW NW 27-1s-10w, dry, TD 3,437 ft.

Effingham County: W. W. Toler 1 Ellis, NW SW NE 13-6n-6e, dry, TD 2,900 ft.

Fayette County: Frank Strickland 1 Hall, SW NW NW 28-5n-1e, dry, TD 3,097 ft.

Stanford Oil Co. 1 Lotz et al, NW SE NE 30-5n-3e, dry, TD 2,159 ft.

Franklin County: Paul Mosebach 1 Valier, NW SW SE 36-5s-1e, dry, TD 2,810 ft.

Herman Graham 1 Wilcox, N½ NE NE SE 18-5s-3e, dry, TD 2,964 ft.

Hamilton County: J. M. Miller-A. Volter 1 Mayberry, NW NW SW 21-6s-7e, dry, TD 3,252 ft.

Montgomery County: Collins Brothers Oil Co. 1 Mitchell, NW NW SE 24-10n-1w, dry, TD 2,825 ft.

Saline County: Ralph Halbert 1 Wiseman, SE SE NW 11-8s-6e, dry, TD 3,128 ft.

Sangamon County: Oil Management, Inc., 1 Bunn, NE NE NE 30-15n-3w, dry, TD 1,827 ft.

Shelby County: Lynch Oil Co. 1 Dove, NE NE SW 27-11n-4e, dry, TD 3,301 ft.

A. M. Branyan 2 Branyan, SE NW SE 17-13n-2e, dry, TD 2,521 ft.

Wayne County: Skiles Oil Corp. 1 Howe, SW NW NE 3-1n-6e, dry, TD 3,313 ft.

White County: Hayes Drilling Co. 1 Britton, NE NW SW 33-4s-10e, dry, TD 3,272 ft.

INDIANA SUCCESSFUL WILDCATS

Gibson County: Ryan & Sharp 1 Black, SW NW SW 4-3s-10w, IP 40 bbl., Aux Vases 2,045-52 ft., TD 2,170 ft. (opens Fort Branch North pool).

Pike County: Cline & Lambert 1 Charity farms, NE SE NW 31-1s-7w, IP 8 bbl., Cypress 1,131-38 ft., TD 1,388 ft. (opens Winslow pool).

Posey County: Indiana Farm Bureau 1 Ruse, SW NW NW 18-6s-13w, IP 90 bbl., McClosky 2,876-81 ft., TD 2,966 ft. (opens Solitude South pool).

INDIANA WILDCAT FAILURES

Knox County: Joe Bander 1 Hess Sur., 12-2n-9w, dry, TD 1,856 ft.

Monroe County: Pioneer Oil Co. 1 Stafford, SE SW NW 33-7n-1e, dry, TD 1,833 ft.

Vanderburgh County: Moran Drilling Co. 1 Harville, W½ SE SE SW 6-6s-11w, dry, TD 2,771 ft.

G. L. Reasor 1 Deacon, NW NE NW 36-5s-10w, dry, TD 2,361 ft.

EASTERN KENTUCKY

ASHLAND.—In Lee County and on the waters of Big Sinking Creek in Big Sinking pool, Ashland Oil & Refining Co. is drilling at 1,050 ft. on 269 Eureka Coal & Mineral Co. Well is designed to test entire Corniferous lime section, the normal pay for the area.

In Johnson County and on the waters of Keaton Fork in Martha oil pool, Ashland Oil & Refining Co. is coring Weir (Mississippian) sand at 850 ft. on 22 William Lester. Weir was topped at 790 ft.

In Pike County and Big Sandy gas field, United Fuel Gas Co. has completed 30 Kentland Coal & Coke Co. as a dual completion in the Berea and Devonian black shale formations. At a total depth of 4,266 ft., well gaged 273,000 cu. ft. of gas daily with rock pressure of 43 psi.

LEGAL

1,120 ACRES of Tribal Indian lands located in Townships 5 and 6 South, Range 9 West, within the jurisdiction of the Uintah and Ouray Reservation, Utah, are being advertised for lease, bids on which will be opened August 9 at 2:00 P.M., at the office of Forrest R. Stone, Superintendent, Uintah and Ouray Agency, Fort Duchesne, Utah. Full particulars may be obtained from Mr. J. R. Schwabrow, U. S. Geological Survey, Casper, Wyoming, or from the Uintah and Ouray Agency.

LEGAL

Notice is hereby given that SEALED BIDS will be received until 2:00 p.m. August 9, 1951, and opened at that time in the office of the Superintendent of the Wind River Indian Agency, Fort Washakie, Wyoming, for the leasing of the following units of ceeded tribal land located in Fremont County, Wyoming, for oil and gas mining purposes. Parcel No. 1: N½ SE¼, SW¼ SE¼, Sec. 14, Twp. 3 N, R. 1 W, containing 120 acres more or as surveyed. Parcel No. 2: NE¼ Sec. 14, Twp. 3 N, R. 1 W, containing 160 acres more or less as surveyed. The following units of ceeded tribal land is being offered, and a lease will be drawn on the applicable Government form. The right is reserved to reject any and all bids. The successful bidder will be required to pay the cost of advertising. The lessee must pay as advance rental $1.25 per acre per annum. The adequacy of the bonus offer will be determined by the U. S. Geological Survey. A suitable bond will be required, and such bond must be approved by the Commissioner of Indian Affairs. The responsibility of complying with any requirements of the Federal Documentary Stamp Statutes will be left with successful lessee. The lease will be sold to the highest bidder for a bonus offer upon an **acreage basis** in addition to the royalty of 12½%. The successful bidder must deposit with the Superintendent of the Wind River Indian Agency, on the date of the sale, a certified check or bank draft on a solvent bank in an amount equal to 20% of the bonus bid and of the first year's rental, as a guaranty of good faith. The check is to be made payable to the TREASURER OF THE UNITED STATES. The lease must be completed and filed with the Superintendent within 20 days from the date it is received by the lessee for execution and returned with the remainder of the bonus bid, the balance of the first year's rental, a filing fee of $10.00, and the cost of the printed forms. Failure in any of these conditions may subject the bid to cancellation without further notice and forfeiture of payments already made. The lease on the above ceeded tribal units, will be drawn pursuant to the Act of August 21, 1916 (39 Stat. 519) and the regulations, Part 192, Title 25, C.F.R. The lease issued pursuant to this notice will be made for a term of twenty years from the date of approval by the Commissioner of Indian Affairs and as long thereafter as oil and/or gas is produced in paying quantities. The rate of royalty will be 12½% of the value of all oil, gas, and/or natural gasoline, unless the lessor, with the approval of the Commissioner of Indian Affairs, elects to take royalty in kind. All bids should be addressed to the "Superintendent, Wind River Indian Agency, Fort Washakie, Wyoming," in a plain envelope marked: BID FOR OIL AND GAS MINING LEASE, STEAMBOAT BUTTE FIELD, TO BE OPENED AT 2:00 P.M., AUGUST 9, 1951. For further information call or write Lands Department of the Wind River Agency. Lynn W. Jenkins, Land Officer.

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EQUIPMENT FOR SALE

USED ROTARY AND CABLE TOOL DRILLING TOOLS, WIRE LINES, E. A. KELLY, BOX 861, OKLAHOMA CITY. PHONE 5-6407.

FOR SALE: Seamless casing and tubing new and second hand. Phone Rogers Pipe and Supply Co., Tulsa, Okla.

BUCYRUS, Ft. Worth, Wichita spudders. Franks, Longyear rotaries. Good used Equipment. Also tools, pipe, cable. Everything for well drilling. Fishing tools rented—Pressey & Son, Pueblo, Colo.

ONE STRING of cable drilling tools, 5,000 ft. capacity with Parkersburg Rig and Rüse Drilling Motor. Tools to drill 13, 10, 8, and 7-inch holes. Everything in A-1 condition. Complete, $6,500. Contact Weir Walker, R.D. #4, Washington, Pa.

FOR SALE: Superior - General Electric natural gas engine - generating unit. 1-685 hp., 480 kw., 327 r.p.m., 480 v., 3-phase, 60-cycle. 1—510 hp., 350 kw., 400 r.p.m., 480 v., 3-phase, 60-cycle. Complete with exciters and generating panels. All in A-1 condition. Will consider selling engine separately. Max E. Landry, Inc., Tulsa, Oklahoma. Phone 5-5639.

Gaso Duplex 4½" x 6" Power Pumps with Chrysler C-36 Engines, skid mounted, immediate delivery. Also Byron Jackson, Carter Centrifugal Units. Westinghouse 20-25-50 KW Generating Units.

H. H. COFFIELD
Attn.: W. H. ORR
Phones: 132—Rockdale, Texas
AT-3427—Houston, Texas

FOR SALE

Mayhew Model 2000 Drill. Mounted on 1948 Chevrolet—Thornton Tandem. New Gardner-Denver 4½ by 6 Pump. Auxiliary Motor. 40-Foot Hydraulic Lift Mast. Sacrifice for Quick Sale.

Frank Herring
303 Orpheum Building Telephone 3-1507
Wichita, Kansas

FOR SALE

CASING AND TUBING NEW & USED

10000'—7" OD 20# L.W. Used Casing
10000'—5½" O.D. 17# L.W. Used Casing
5000'—5½" O.D. 13# L.W. Used Casing
20000'—2" REG: L. W. R-1 Tubing
7200'—10¾" O.D. 31.20# P.E. G.B. Line Pipe, New
10000'—5½" O.D. 14# S. 10V R-2 Casing, Used
20000'—2" E.U.E. 4.70 10V & 8-R Used S Tubing.

Sabine Machine & Supply Co.
Kilgore, Texas
Phone 3094, 3185, 3436

EQUIPMENT FOR SALE

FOR CABLE TOOLS
DEGEN PIPE AND SUPPLY CO.
Box 107, Red Fork Station, Tulsa, Oklahoma

DRILLING Mud. Colo. Bentonite, it swells, it jells. Few equal, none better. Send for sample. Our price saves you money. Pressey & Sons, Pueblo, Colorado.

FOR SALE: R. L. Cardwell with GAK Waukesha, 1st class condition, $5,000. One super model Wilson single drum servicing unit, 80 hp. Waukesha, 4,000' wire, all tubing tools, mounted on GM 4-wheel drive truck. $3500. Phone Rogers Pipe and Supply Co., Tulsa, Okla.

EQUIPMENT FOR SALE

PIPE
ALL SIZES: LINE PIPE AND CASING, TANKS, AND OILFIELD SUPPLIES. EDCO PIPE & SUPPLY CO., PHONES 933 OR 1298, DRUMRIGHT, OKLA.

90 HP Direct Driven Superior Gas Compressor. Location, Oklahoma. Alfred B. Kern, 223 Wright Bldg., Tulsa, Oklahoma.

BOLTED STORAGE—3 A.P.I. 10,000-bbl. capacity, clean steel tanks, good condition, located Grapeland, Texas. Geier-Jackson, Inc., 1010 Gulf States Bldg., Dallas, Texas. Phone LD-649.

PIPE FOR SALE!

UNUSED STANDARD BLACK LINE PIPE:

180,000' ½" Standard Black, Plain Ends, 21' Lengths.
45,000' ¾" Standard Black, Plain Ends, 21' Lengths.
70,000' 1" Standard Black, Threaded & Coupled, 21' Lengths.
120,000' 1¼" Standard Black, Threaded & Coupled, 21' Lengths.
110,000' 1½" Standard Black, Threaded & Coupled, 21' Lengths.
110,000' 2" Standard Black, Plain Ends, 21' Lengths.
7,177' 2½" Standard Black, Plain Ends, 21' Lengths.
10,000' 3" Standard Black, Plain Ends, 21' Lengths.
3,200' 3½" Standard Black, Plain Ends, 21' Lengths.
35,000' 4" (4½" O.D. x .188" Wall) 8.7# Welded Line Pipe, Beveled Ends, 30'-40' Lengths.
3,000' 5" Standard Black, Plain Ends, 21' Lengths.

UNUSED SEAMLESS STEEL TUBING, RANDOM MILL LENGTHS:

5,000' 1½" O.D. x Approx. .120/.134" Wall, 1.85#.
25,000' 1.900" O.D. x Approx. .390/.415" Wall, 6.23#.
15,000' 2" O.D. x Approx. .130/.165" Wall, 3.01#.
6,500' 2¼" O.D. x Approx. .170/.190" Wall, 3.89#.
5,000' 2⅜" O.D. x Approx. .300/.375" Wall, 7.5#.
5,000' 2½" O.D. x Approx. .130/.160" Wall, 3.72#.
3,000' 2½" O.D. x Approx. .188/.250" Wall, 5.48#.
2,000' 3" O.D. x Approx. .188" Wall, 5.42#.
3,000' 3" O.D. x Approx. .200/.250" Wall, 7.2#.
8,000' 3" O.D. x Approx. .270/.320" Wall, 8.7#.
3,000' 3" O.D. x Approx. .300/.350" Wall, 9.65#.
3,000' 3¾" O.D. x Approx. .375/.438" Wall, 14.5#.
10,500' 4" O.D. x Approx. .140/.160" Wall, 6.4#.
3,000' 5" O.D. x Approx. .600/.650" Wall, 29.2#.
2,000' 5¾" O.D. x Approx. .370/.450" Wall, 23.2#.
1,000' 6¼" O.D. x Approx. .170/.210" Wall, 13.0#.
1,000' 6¾" O.D. x Approx. .180/.250" Wall, 15.2#.

This material is excellent for welded gas or flow lines; minimum and maximum wall thicknesses available for high and low pressure work.

ACT NOW! PHONE OR WIRE COLLECT YOUR REQUIREMENTS TODAY

A. J. STRUBEL, Broker
SIDney 1781 (Day Phone) HUDson 8132 (Night Phone) 4948 Murdoch, St. Louis, Mo.

EQUIPMENT FOR SALE

FOR SALE: One 4" x 6" Model AXG Brass fitted Gardner-Denver Pump, skid mounted with Hercules Engine, V Belts and sheaves. Pump and engine completely overhauled and in first-class condition. $1000.00. D. H. Walkup, American Supply Co., Kilgore, Texas.

FOR SALE: One drilling rig complete including 127' Lee C. Moore mast and 7,200' of 4½" drill pipe. Rig capacity 7,500 ft. Now operating in Oklahoma. All equipment A-1 mechanical condition. For further details and inspection write Box E-132, The Oil and Gas Journal, Tulsa, Oklahoma.

WILSON Super Winch, 145 GKU Engine, 65 foot double pole, on Chevrolet tandem truck. Wilson Super Winch, 140 GKU Engine, 42 foot hydraulic mast, on L-10 International tandem truck. Both rigs equipped with block, hook, swivel, B.O.P., etc. Ready to work. Also two late model Chevrolet pick-up trucks. Price an application. Write W. C. Fatjo, Inc., P. O. Box 414, Lafayette, La., or call 5-6137.

CASING PULLING CONTRACTORS with Hydraulic Equipment: Experienced operators—Pull any size pipe, anywhere. Also will buy wells for salvage. GENERAL CASING PULLING CO., P.O. Box 4387, Oklahoma City. Phone 6-1335.

NATIONAL "50" Compound Double Drum Rig 126' Cantilever Ideco-Moore Mast, 10' substructure, 5000' 4½" drill pipe, this rig complete and in excellent condition. 273 Hermosa Drive, Bakersfield, California. Ph. 53701.

FOR SALE: 2500' 7" o.d. 24 lb. lap weld casing, $2.00; 4500' 7" o.d. 20 lb. lap weld casing $1.75; 1300' 5½" o.d. 17 lb. lap weld casing $1.75. Good body. All good threads and couplings. Prices f.o.b. our yard. M. J. Regan, Coffeyville, Kans.

FOR SALE

2—7' x 46' 22 tray Braun Absorbers, 75 psig.
1—66" x 44' 18 tray Braun Still, 100 psig.
4—7' x 27' x ¼" Riveted Horizontal Tanks, w/4' steel cradles.
Assorted sizes of centrifugal pumps.

C. J. SMITH
433 Mayo Bldg., Tulsa, Okla., Ph. 5-3416

CASING

Have 6,000' of 9⅝" 36 lb. J-55 Seamless Casing on order for third quarter delivery. Would like to trade this tonnage for 5½" or 7" seamless suitable for 9,600' well. Phone 3-8601, Shreveport, Louisiana.

SEAMLESS CASING & TUBING

2400' 7" O.D. 20 lb. Grade C seamless 10V good used seamless casing
800' 7" O.D. 20 lb. Grade C seamless 10V good used seamless casing
3500' 10¾" O.D. 40½ lb. 8 round J-55 good used seamless casing
5000' 5½" O.D. 14 lb. H40 8 round good used seamless casing
3100' 2⅞" O.D. 6.70 lb. 8 round J55 EUE good used seamless tubing

FRANK MORRIS & CO.
4245 S. Cheyenne, Tulsa, Okla.
Phone 2-6247

FOR SALE

SEAMLESS OW CASING AND TUBING

10,000' New J55 2⅞" O.D. external Upset 8 RT R2
10,000' New and Used J55 and H40 5½" O.D. 14# 8 RT R2, Used in hole not over 3 days
3,000' New and Used H40—7" O.D. 17# 8 RT R2, Used in hole not over 3 days
900' #1 Used J55—8⅝" O.D. 24# 8 RT R2
4,000' #1 Used J55—7" O.D.—20" (Republic) 8 RT R2, in hole 2 weeks

MICHIGAN CARLON PIPE CO.
20120 Livernois Ave., Detroit 21, Michigan
Diamond 1-1400

EQUIPMENT FOR SALE

WELL EQUIPMENT: New and used spudders, rotaries, core drills—all sizes and types. Cable tools, drill pipe, bits, pipe. Fishing tools. Everything for Well Service. Pressey & Son, Pueblo, Colorado.

FOR SALE: Bucyrus Erie Model 24L Spudder, Trailer Mounted, Steel Dog House, some Drilling tools. F.O.B. Bartow, Florida, $6,500.00. Would consider 33W Model or Similar Unit in Trade. H. C. Gardenhire, Jr., P. O. Box 271, Bartow, Florida.

FOR SALE: Used oil barges, excellent for conversion to drilling and material barges. Write Commercial Petroleum & Transport Co., 344 Esperson Building, Houston 2, Texas.

11,500 GAL. 200 lb. pres. U201 propane tank, 25,000 gal. 75 lb. pres. butane tank. L. M. Stanhope, Rosemont, Pa.

FOR SALE: Ideal slush pump, Model C-150. Melton Supply Company, Seminole, Oklahoma.

EQUIPMENT NOT IN USE: Did you find a buyer in this column for the equipment you have for sale. Someone wants it and an "Equipment For Sale" classified advertisement in the Journal will find a buyer. See box heading for classified rates or write The Oil and Gas Journal.

EQUIPMENT WANTED

WANTED: Cable 2 MACHINE, depth 3500'. Complete with tools. Give price and location first letter. Box 198, Gorham, Kansas.

WANTED

New or used for immediate delivery—two 30,000 gallon liquid Propane storage tanks. Phone or wire:

R. W. BOOKER & ASSOCIATES
1722 Olive Street St. Louis 3, Mo.
GArfield 1476

WANTED

FOR DEFENSE PLANT

2—Cone Bottom Bins, approximately 12' diam., 28' overall, welded at least ⅜" thick.
1—Steel Tank, approximately 35' x 35'.
3—Steel Tanks, 10,000 to 30,000 gal. cap., Welded, 200# ASME stamped.

HEAT & POWER CO., Inc.
70 Pine St., N. Y. 5. Hanover 2-4890

FLOOD RELIEF

HELP REQUESTED
Urgently needed for Immediate Delivery

ALUMINUM, STEEL AND STAINLESS STEEL
Structural Shapes
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Help us keep industry moving.

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Channel your available material where it is urgently needed. Submit detailed offerings.

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SONKEN-GALAMBA CORP.
2nd and Riverview (X-742)
Kansas City 14, Kansas
THatcher 9243

EQUIPMENT WANTED

WANTED: A rotary, complete depth 6000'. Give price and location. Box 198, Gorham, Kansas.

WANT EQUIPMENT: Did you find the equipment you wish to purchase in this column? If not, use an "Equipment Wanted" classified advertisement to find it. It is available somewhere and Journal classified advertisements will find it. See box heading for classified rates, or write The Oil and Gas Journal.

HELP WANTED

PROCESS Engineer who has had at least five years refinery experience. Southwest Refinery. Box E-232, The Oil and Gas Journal, Tulsa, Oklahoma.

WANTED: Petroleum engineer minimum experience 4 years including field operations for General Headquarters office located in Oklahoma City. Apply in writing only giving full particulars. Sohio Petroleum Company, Room 1254, Skirvin Tower, Oklahoma City.

PETROLEUM Engineer with approximately 10 years production experience, to pump lease and operate well servicing equipment, to live on premises near Casper, Wyoming. State experience, salary and qualifications. Ameera Oil Company, 139 South Beverly Drive, Beverly Hills, California.

CORROSION engineer, under 50, degree in electrical engineering, preferably experienced in pipe-line corrosion control. P. O. Box 2486, Kansas City 6, Missouri.

ENGINEER, young mechanical, must have real writing ability. P. O. Box 2486, Kansas City 6, Missouri.

SEISMOGRAPH. Excellent opportunity for experienced geophysicist with aggressive independent contract company to supervise contract crew in Texas. Salary dependent on experience. Write giving details, all replies held strictly confidential. Box E-246, The Oil and Gas Journal, Tulsa, Okla.

ENGINEERS, Executives, Technical Men. Salaried positions—$3600 to $30,000. This confidential service for outstanding men who desire a change of connection. Will develop and conduct preliminary negotiations without risk to present position. Send name and address for details. Tomsett Associates, 1904 Berger Bldg., Pittsburgh 19, Pa.

REFINERY PERSONNEL

Major company's refinery expansion in Louisiana provides opportunities for experienced technical and non-technical men. Positions open range from top process supervisors through instrument men, stillmen, and other refinery crafts. Give experience, education, age and salary expected. Replies kept confidential. Industrial Relations Department, P. O. Box #2, New Orleans, La.

GOOD OPPORTUNITY

for young

CHEMICAL ENGINEER

IN PETROLEUM AND CHEMICAL FIELDS

. . . furnace builders, specializing in petroleum and chemical heaters for crude distillation, cracking, etc., seeks services of young chemical engineer (recent graduate considered).

Excellent opportunity with small, well established firm located in New York City.

All replies confidential, our organization knows of this advertisement.

Box E-243

THE OIL AND GAS JOURNAL
Tulsa, Oklahoma

HELP WANTED

FOREIGN and Domestic Oil Employment Directory covering the oil industry, showing where to apply for jobs. Price $5.00. Oil Industry Mailing List, Box 2563, Tulsa, Okla.

HELP WANTED

MECHANICAL Engineer who has had actual supervisory experience in refinery of machine shop, pump, engine and turbine repair. Southwest refinery. Box E-231, The Oil and Gas Journal, Tulsa, Oklahoma.

GEOLOGIST

Established independent oil company requires Geologist with general knowledge and experience in petroleum engineering, leasing, reserve studies, contract analysis and negotiations. Must have college degree, minimum of eight years experience in field and office work, and be qualified to direct leasing, exploration and development involving up to $2,000,000 yearly. Permanent position, located in Shreveport, Louisiana.

Replies will be treated confidentially.

Give complete relevant information in letter directed to Post Office Box 4157, Centenary Station, Shreveport, Louisiana.

OPPORTUNITIES FOR TECHNICAL REFINERY PERSONNEL

for

LARGE INTERNATIONAL OIL CO.

Entertaining applications of graduate chemical, mechanical, structural and electrical engineers for refinery engineering assignments at home and abroad.

Engineers with refinery experience and also recent graduates will be considered.

Box E-143, The Oil and Gas Journal, Tulsa, Oklahoma

OPPORTUNITIES
FOR EXPERIENCED ENGINEERS

Atomic Energy Installations
OAK RIDGE, TENNESSEE
AND PADUCAH, KENTUCKY

DESIGN-DRAFTING — chemical plants, structures, piping, utilities, alterations.

POWER—design, testing, construction of large electrical power generation and distribution installations.

MACHINE DESIGN—jigs, fixtures, gadgets, remote control equipment.

PROCESS—chemical process and equipment design, vacuum or high-pressure systems, pilot plant operation, maintenance.

CONSTRUCTION—plant design and construction, co-ordination of procurement and installation of process equipment.

SAFETY—welding inspection, hoist and vessel inspection, fire protection.

NUCLEAR REACTORS—chemical and mechanical engineers for design, development, construction.

INSTRUMENTATION—design, development and industrial application of electronics and pneumatic instruments.

AIR-CONDITIONING — HEATING — AND VENTILATING—design, installation, maintenance of plant systems.

B.S. Degree or its equivalent minimum educational requirement.

Salary Commensurate With Training and Experience

Give detailed information concerning experience, education, personal history, references, present salary and salary expcted.

Central Technical Personnel Office
Carbide and Carbon Chemicals Co.
A Division of Union Carbide and Carbon Corporation
P. O. Box P — Oak Ridge, Tennessee

HELP WANTED

A CHEMICAL Engineer—Major Oil Company Refinery in Oklahoma. State qualifications and salary expected. Write Personnel Department, Box 381, Tulsa, Oklahoma.

SALES engineers to represent hydraulic oil well pumping equipment in Mid-Continent area. Excellent opportunity for advancement. Give details of experience, education, age and availability in first letter. Confidential. Box E-242, The Oil and Gas Journal, Tulsa, Oklahoma.

WANTED: Experienced Podbielniak operator. When applying furnish full details as to education and experience. New Mexico Asphalt and Refining Company, P. O. Box 367, Artesia, New Mexico.

AGGRESSIVE OIL EXECUTIVE — Substantial independent producing company wants aggressive, high type, responsible executive as Manager West Texas-New Mexico Division. Applicant should be under 35 years of age, 10 years experience land and geological work preferably West Texas-New Mexico area. Applicant must be equipped to find and negotiate for wildcat, undeveloped, and developed properties and leases, appraise submittals, manage present West Texas office. Excellent compensation. When replying give full details, include photograph. Our present employes not considered for this position. Box E-194, The Oil and Gas Journal, Tulsa, Oklahoma.

EXCELLENT opportunity open for engineer capable of directing gas compressor sales program in Southwest. Must have previous experience and acquaintance in the oil and gas companies in that area. Reply to Box E-213, The Oil and Gas Journal, Tulsa, Oklahoma.

THE POSITION YOU WANT: Oil industry companies are looking for men to fill every conceivable kind of position. If you didn't find the position in this column that you are looking for, use a "Situation Wanted" classified advertisement to state your qualifications. Some company is probably looking for your ability. See box heading for classified rates or write The Oil and Gas Journal.

SITUATIONS WANTED

PRODUCTION MAN NOW AVAILABLE—Experienced in: drilling; completion; flowing wells; pumping wells; workovers; salt-water disposal; secondary recovery. Box E-238, The Oil and Gas Journal, Tulsa, Oklahoma.

EXPERIENCED Gas Engineer desires change in location. Registered in Texas. 22 years' experience. Familiar with all phases natural gas, gasoline plant, cycling plant, and gas transmission line work. Desire location in Southwest. Would consider foreign. Minimum salary $8000.00 Domestic, $10,000 Foreign. Box E-239 The Oil and Gas Journal, Tulsa, Oklahoma.

GEOLOGIST, operating as an independent, wishes to become associated with company, individual, or group on a salary-interest basis. Have been associated with the oil industry better than fifteen years in geological and geophysical exploration, development, leasing, and other phases of operation, and should be an asset to one needing an experienced man. Capable of planning program and directing operations. Interview to be arranged. Box E-245, The Oil and Gas Journal, Tulsa, Oklahoma.

INDEPENDENT oil operator with outside income, 35 years old, married to attorney, would like position foreign country with oil company or government. Speaks French, Spanish, German and Italian. Thirteen years experience in land, seismograph crew supervision, drilling, producing, and developing Texas Gulf Coast. Three years college education. Wants to get away from high tax but would not consider anything less than a two year contract. Write Box F-244, The Oil and Gas Journal, Tulsa, Oklahoma.

ATTENTION: Well established oil well drilling contractor desires to manage and supervise: Individuals', groups', small or medium-sized oil companies' drilling, production and operating problems in Central and Western Texas, and New Mexico. Personal interview by appointment is desired. Makin Drilling Company, Box No. 131, Ph. No. 131, Hobbs, New Mexico.

FORMER Independent Oil Operator ten years, with legal education, plus eight years Wall Street experience, desires connection raise funds exploratory well drilling from excess profits taxpayers. Box D-938, The Oil and Gas Journal, Tulsa, Oklahoma.

SITUATIONS WANTED

DRILLING Contractor operating in West Texas and New Mexico desires to contact small or medium-sized independent oil company who needs an operating manager. Personal interview desired. Twenty years experience in all phases of the oil industry. Address replies to Box D-644, The Oil and Gas Journal, Tulsa, Oklahoma.

CHEMICAL Engineer: M. S. Degree, ten years diversified experience in Refining and Natural Gasoline. Age 35. Desire responsible position in Refining, Petro-Chemical or Sales. All replies considered. Box E-217, The Oil and Gas Journal, Tulsa, Oklahoma.

PETROLEUM Engineer-Geologist: 31, six years major company experience field engineering and subsurface geology Kansas, Oklahoma, North and South Texas. Desires connection with aggressive independent producer in Mid-Continent or Rockies. Best of references. Write Box E-216, The Oil and Gas Journal, Tulsa, Oklahoma.

RETIRED Textile Business man, 54, desires association with small operator, can furnish bank reference, run office, operate typewriter. Familiar with credit problems. Box E-219, The Oil and Gas Journal, Tulsa, Oklahoma.

PLANT SUPERINTENDENT
Competent and experienced. Excellent record of efficient operations, maintenance and construction. Box E-229, The Oil and Gas Journal, Tulsa, Oklahoma.

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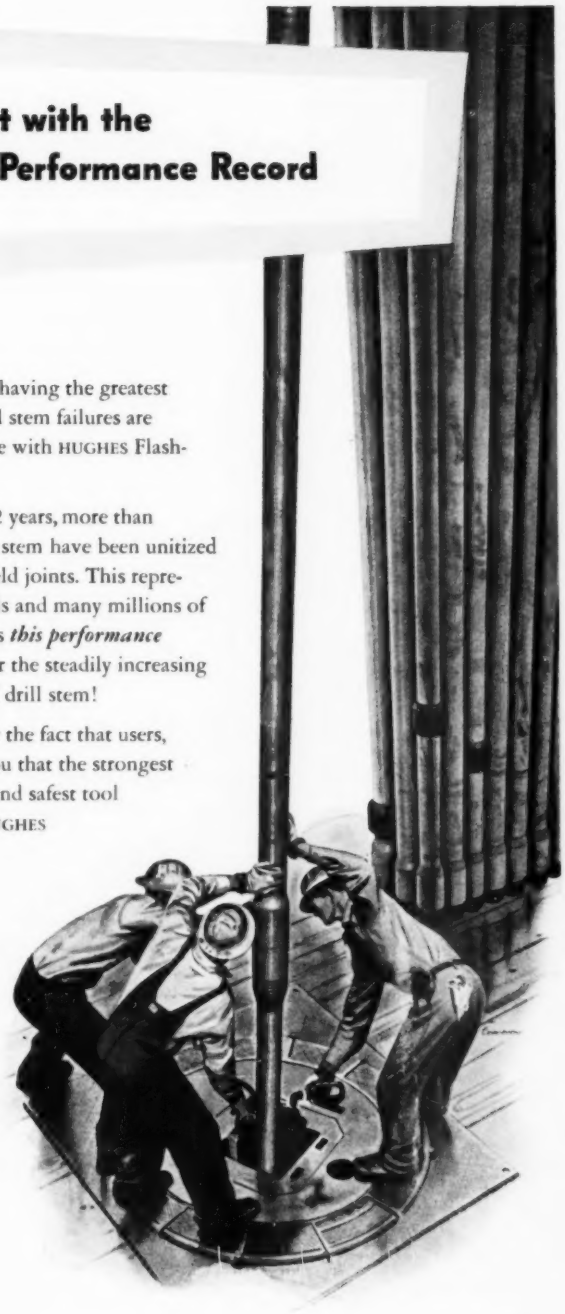

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